



Carnegie Mellon University



Undergraduate Catalog 2008–2010

Carnegie Institute of Technology

The College of Fine Arts

The College of Humanities and Social
Sciences

The H. John Heinz School of Public Policy
and Management

Mellon College of Science

The School of Computer Science

Tepper School of Business

Carnegie Mellon University in Qatar

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Inquiries concerning application of these statements should be directed to the Provost, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, telephone 412-268-6684 or the Vice President for Campus Affairs, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, telephone 412-268-2056. Carnegie Mellon University publishes an annual campus security report describing the university's security, alcohol and drug, and sexual assault policies and containing statistics about the number and type of crimes committed on the campus during the preceding three years. You can obtain a copy by contacting the Carnegie Mellon Police Department at 412-268-2323. The [security report](#) is also available online.

Obtain general information about Carnegie Mellon University by calling 412-268-2000.

Foreword

This catalog was primarily assembled to meet the needs of current undergraduate students, faculty, and administrators regarding the University's academic programs, policies and services. We have tried to present in a readable format the current information available at press time.

While the audience for this catalog is the campus community, we recognize that applicants, prospective students, and many other people will read this material. This publication should give them an understanding of the University.

Since this is a two-year catalog, an addendum will be bound in the back of catalogs distributed after August of 2009. The addendum will be an update of changes in University academic programs, policies and services. Separate copies of the addendum will be published for distribution to undergraduate students and to faculty and administrators in 2009.

In the interim, new courses will be announced in the course schedules which are usually available in November and April and on the Web (www.cmu.edu/hub). I will be happy to receive updated information from any member of the campus community so that this catalog will maintain its usefulness until 2010.

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Look at Carnegie Mellon

Excellence in Practice and Learning for Life

Carnegie Mellon emphasizes a deep connection between theoretical knowledge and practice: the university's interdisciplinary approach to education stresses the practical application and analysis of knowledge in institutional, social and historical contexts. "On a campus of 110 acres, research and teaching are conducted in more than 30 different fields of the arts, humanities, engineering, the sciences, social sciences, management and public policy. Students and faculty in these areas are in daily contact with one another, pursuing interdisciplinary projects, redefining fields of knowledge, pushing their own visions of the possible and contributing to the world around them," writes Jared L. Cohon, the eighth president of Carnegie Mellon in "The Innovative University," a volume of writings that celebrated Carnegie Mellon's centennial in 2000. Carnegie Mellon graduates are excellent practitioners in their chosen fields. The university is in the process of enriching and complementing this education to ensure that our students also gain broader, well-informed perspectives that will help them grow and change with their professions; interact wisely with the natural environment; and be responsible and informed citizens in an increasingly technological world and complex global culture.

From Technical School to International University

In a letter written in 1900, industrialist and philanthropist Andrew Carnegie offered to give the city of Pittsburgh \$1 million in bonds to fund a technical institute. The city provided 32 acres of land near Schenley Park, and the institution became known as the Carnegie Technical Schools. According to Carnegie's plans, the institution would train the sons and daughters of working-class families in five schools: Science and Technology, to train draftsmen and engineer's assistants; Fine and Applied Arts, for designers and art workers; Apprentices and Journeymen, for mechanics in manufacturing and construction; and Margaret Morrison Carnegie College, for home economists or secretaries. Within two decades, the Carnegie Technical Schools offered bachelor's, master's and doctor's programs, and fittingly changed its name to the Carnegie Institute of Technology.

In 1967, the trustees of the Mellon Institute and the Carnegie Institute of Technology merged the two institutions and adopted the name Carnegie Mellon University. In 1968, Margaret Morrison Carnegie College closed and the university organized a new College of Humanities and Social Sciences. New graduate-level colleges and schools also flourished, including the Graduate School of Industrial Administration (GSIA), the Heinz School of Public Policy and Management, and the School of Computer Science. As time progressed, new research centers and institutes developed on and off campus in specialties ranging from art conservation to sustainable computing. In 2004, GSIA was renamed the Tepper School of Business after alumnus David A. Tepper.

The Carnegie Institute of Technology has developed from a regional, technical college into Carnegie Mellon University, a selective, international research university that consistently ranks among the nation's best colleges in U.S. News & World Report, Newsweek and BusinessWeek magazines. The university is also a leader in environmental sustainability and energy efficiency, and is home to the nation's first Leadership in Energy and Environmental Design (LEED) certified dormitory. University Business magazine identified Carnegie Mellon as one of the nation's Higher Education Sustainability Stars.

Undergraduate students can pursue majors in six of the university's seven colleges: the Carnegie Institute of Technology (engineering), the College of Fine Arts, the Tepper School's business administration program, the College of Humanities and Social Sciences, the Mellon College of Science, and the School of Computer Science. Carnegie Mellon also has campuses in California and Qatar and is expanding its presence in Europe, Australia and Asia with master's programs and other educational partnerships.

A Unique Educational Experience

The university's diversity, focus on strong student-faculty ties and commitment to education outside the classroom combine to create a learning environment that is as uniquely Carnegie Mellon as the Tartan plaid on the kilts of its bagpipers.

Carnegie Mellon strives for a campus culture that reflects a fundamental respect for different ways of living, working, and learning so every student has the opportunity to reach her or his potential. The university community is diverse, with roughly 5,300 undergraduates, 3,500 graduate students, and more than 1,200 faculty members. About 10% of undergraduate students are underrepresented minorities and 15% hail from countries outside the U.S. Faculty and graduate students also come from across the globe.

The university's small student-to-faculty ratio gives students the opportunity for close interaction with their teachers — an essential component of academic success. But while professors spend a great deal of time with students, they also expect them to develop initiative, to critically assess their own progress and to work as teams. Working together, students and faculty create real-world projects with immediate impact. A design professor might critique a student's sketches of a company logo, or a team of students will work with professors and researchers to design an autonomous robot for a race across the desert. Faculty at Carnegie Mellon take an interest in their students' questions and concerns beyond the classroom. Some serve as academic advisors, while others seek undergraduate assistance with research projects or oversee student-proposed projects.

Equally important to the Carnegie Mellon education is the metacurriculum — the learning that occurs outside classes through community service, interacting and learning in the university's international community, or even just living in the residence halls.

Structure to Succeed, Freedom to Explore

A Carnegie Mellon education is marked by its strong focus on fundamental and versatile problem-solving skills in a specific discipline, but the university respects and values students' varied talents and interests that often span many specialties. At Carnegie Mellon, students can explore more than one field of study while developing the strong professional core that is the hallmark of a Carnegie Mellon education. The university encourages students to expand their thinking in new and exciting dimensions, whether by taking courses from disciplines across the university or pursuing a double major or minor — frequently in a different college. Students can even design their own majors. In a community rich with seven colleges, the academic options are as varied as the students who pursue them.

Though academic interests may differ, the university has structured its programs so students develop skills vital to all professions, with communication and reflective practice acting as the common threads connecting these skills. In order to excel in any field and lead a life of social responsibility and lifelong learning, students must be able to understand the theoretical basis and practical implications of knowledge and action, convey ideas and information effectively, and be reflective practitioners. Carnegie Mellon instills these qualities in students and gives them a wide array of perspective and opportunities by creating an environment of learning-by-doing, providing them with a strong analytical background, and encouraging them to do and make.

Strength in Research and Artistic Creation

At Carnegie Mellon, faculty members aren't just devoted teachers. They conduct groundbreaking research, create new and exciting art, and contribute to a growing global scholastic community. The university's faculty are continuously innovating, and the new knowledge they create and the methods they discover routinely benefit classroom learning. Each college and dozens of special centers focus on issues and developments that affect the world beyond Carnegie Mellon.

Researchers in the Mellon College of Science received a \$13.3 million grant to develop the National Center for Networks and Pathways, which will generate molecular biosensors that will change the way scientists look at living cells. A study by researchers in the College of Engineering found that cell phones and other portable electronic devices can interfere with the normal operation of critical electronics on airplanes. Meanwhile, in the university's College of Humanities and Social Sciences, faculty have made critical strides toward understanding what causes autism and how it can be treated more effectively. The National Science Foundation recently funded

a new Quality of Life Technology Engineering Research Center — a joint effort of Carnegie Mellon's School of Computer Science and the University of Pittsburgh — that will design and commercialize technology to help older adults and people with disabilities live independently and productively. New research from the Tepper School of Business showed small retailers that the best way to compete with megamarts is to use their existing customer data to develop new sales and marketing strategies. Students and faculty in the university's School of Design have collaborated with local foundations to create Explanatoids, cartoons designed to illustrate the importance of science, math and technology to the Pittsburgh region while stressing the role girls play in the careers of the future. Just down the road, faculty in the Heinz School are breaking new ground with studies on the different ways men and women negotiate.

Exploring Research and Creative Projects

Faculty aren't the only people busy with research on campus. Research is a vital component of undergraduate education at Carnegie Mellon. Students can initiate projects of their own or become involved with existing ones on campus. The Department of Biological Sciences, for example, has faculty mentors who help interested students find research opportunities that support their own intellectual curiosity. Drama students participate in every facet of productions, from set construction to acting. Students across campus are encouraged to work with faculty to pursue their own interests, and most departments offer courses for independent study that allow undergraduates to work on projects of their own design under the guidance of a faculty member.

Research projects often come with a financial cost, but Carnegie Mellon offers many sources of funding for students conducting independent research and creative projects. One popular source of funding is the university's Small Undergraduate Research Grant (SURG) program offered through the Undergraduate Research Initiative. (For more information, see the Undergraduate Research Initiative section in this catalog under "University Services.") These types of funding programs combined with the support and encouragement offered by faculty and staff on campus bring research — traditionally the mark of graduate education — into the undergraduate realm.

The World of Carnegie Mellon

Carnegie Mellon is often described as a competitive place — and it is. The university selects students from among the best in the world, so attending Carnegie Mellon means that you'll be with students who, like you, were at the top of their classes in high school. The university also stresses collaboration and teamwork, often across disciplines, where students share common goals and tasks while still bringing something unique to the interaction. Carnegie Mellon students are serious scholars who want to excel. The atmosphere is intense and demanding, but also encouraging and rewarding. Carnegie Mellon graduates enter society prepared to assume even greater challenges and equipped with an awareness of their own strengths and abilities.

But Carnegie Mellon students still have fun, and spend their free time planning for the coming weekend and forging some of the strongest friendships they've ever known. Students don't just develop a strong work ethic at Carnegie Mellon — they develop a strong sense of community. Through residence hall living, community service, group projects and numerous activities and clubs, students find they can belong to a range of communities. Carnegie Mellon also has the tradition of Spring Carnival, an annual three-day event whose buggy races and booths involve students and alumni from a multitude of academic and cultural backgrounds.

Carnegie Mellon Impacts the World

As a Carnegie Mellon graduate, you'll join a highly respected group of individuals who have changed the world as we know it. Whether pursuing further education or entering the work force, alumni consistently achieve the high goals they've set for themselves in a wide variety of academic and professional fields. One alumnus wrote the songs for "Godspell," while an alumna won the Tony Award for Best Performance by a Leading Actress in a Play for her performance in the Pulitzer Prize-winning "Doubt." Carnegie Mellon alumni created and starred in "Hill Street Blues," "L.A. Law," "NYPD Blue," "ER" and "Lost." More than 2,000 of our graduates are corporate chairs, presidents or vice presidents. Some 1,400 alumni are university professors and another 30 are deans. Most major symphonies around the country include Carnegie Mellon alumni.

The university's graduates are also prominent in government, and include a former White House staff assistant, a U.N. delegate and a former first deputy chairman of the presidium of the USSR. An astronaut who walked on the moon holds a Carnegie Mellon degree, as does the project director of NASA's Pioneer Interplanetary Probe. Five Carnegie Mellon alumni have gone on to win the Nobel Prize (three in economics, two in physics), and the works of many former art students hang in the permanent collections of more than 50 international museums.

Mission

To create and disseminate knowledge and art through research and artistic expression, teaching and learning; and to transfer intellectual products to society.

To serve students by teaching them problem-solving, leadership and teamwork skills, and the value of a commitment to quality, ethical behavior, society and respect for one another.

To pursue the advantages provided by a diverse and relatively small university community, open to the exchange of ideas, where discovery, creativity, and personal and professional development can flourish.

A Carnegie Mellon undergraduate education aims to prepare students for life and leadership. In a continually changing world, the most important qualities the university can help students develop are the abilities to think independently and critically, to learn, and to change and grow. As future leaders they must have courage to act, be sensitive to the needs and feelings of others, understand and value diversity, and honor the responsibilities that come with specialized knowledge and power.

Carnegie Mellon's undergraduate educational programs are designed to help students acquire:

- Depth of knowledge in their chosen areas of specialization and genuine intellectual breadth in other fields.
- Creativity and intellectual playfulness, moving beyond established knowledge and practice to create imaginative ideas and artifacts.
- Skilled thoughtfulness and critical judgment, which allow them to evaluate new ideas, identify and solve or explore problems, and appreciate a variety of different forms of analysis and thought.
- Skills of independent learning, which enable them to grow in wisdom and keep abreast of changing knowledge and problems in their profession and the world.
- A set of values, including commitment to personal excellence and intellectual adventure, concern for the freedoms and dignity of others, and sensitivity to the special professional and social responsibilities that come with advanced learning and positions of leadership.
- The self-confidence and resourcefulness necessary to take action and get things done.
- The ability to communicate with others on topics both within and outside their chosen field of specialization.

Most instruction at Carnegie Mellon is focused on fundamentals useful in later learning, rather than on particulars of knowledge and techniques that may soon become obsolete. Advanced courses provide students with the opportunity to refine their skills by applying and exercising the fundamentals they have acquired in earlier courses and by exploring new analytical and creative directions. In a world that has sometimes placed too little emphasis on skill, Carnegie Mellon takes pride in educating students who display excellence in application—students who can do useful things with their learning.

Values, including sensitivity to the feelings, needs and rights of others, are learned in part through example. To this end, the faculty and staff of Carnegie Mellon work to provide a supportive and caring environment that values and respects intellectual, philosophical, personal and cultural diversity. The faculty strive to identify and discuss with their students, both in formal classroom settings and in a variety of informal contexts, their responsibilities as professionals, citizens and human beings, and to teach through example.

The undergraduate programs at Carnegie Mellon are designed to help our students become accomplished professionals who are broadly educated, independent and humane leaders.

Degrees Offered

Carnegie Institute of Technology

- **Interdepartmental**
M.S. in Engineering and Technology Innovation Management
- **Biomedical Engineering**
B.S. in an engineering discipline and Biomedical Engineering
M. of Biomedical Engineering
M.S. in Biomedical Engineering
Ph.D. in Biomedical Engineering
- **Chemical Engineering**
B.S. in Chemical Engineering
M. Chemical Engineering and Colloids, Polymers and Surfaces
M.S. in Chemical Engineering
M.S. in Colloids, Polymers and Surfaces (jointly with MCS)
Ph.D. in Chemical Engineering
- **Civil and Environmental Engineering**
B.S. in Civil Engineering
M.S. in Advanced Infrastructure Systems
M.S. in Architecture–Engineering–Construction Management
M.S. in Civil and Environmental Engineering
M.S. in Civil Engineering
M.S. in Civil Engineering and Management (jointly with the Tepper School of Business)
M.S. in Computational Mechanics
M.S. in Environmental Engineering
M.S. in Environmental Management and Science
Ph.D. in Advanced Infrastructure Systems
Ph.D. in Architecture–Engineering–Construction Management
Ph.D. in Civil and Environmental Engineering
Ph.D. in Civil and Environmental Engineering/Engineering and Public Policy
Ph.D. in Civil Engineering
Ph.D. in Computational Mechanics
Ph.D. in Computational Science and Engineering
Ph.D. in Environmental Science
Ph.D. in Environmental Management and Science
- **Electrical and Computer Engineering**
B.S. in Electrical and Computer Engineering
M.S. in Electrical and Computer Engineering
Ph.D. in Electrical and Computer Engineering
- **Engineering and Public Policy**
B.S. in an engineering discipline and Engineering and Public Policy
M.S. in Engineering and Public Policy
Ph.D. in Engineering and Public Policy and an engineering discipline
Ph.D. in Engineering and Public Policy
- **Information Networking Institute**
M.S. in Information Networking
M.S. in Information Security Technology Management
M.S. in Information Technology — Information Security
M.S. in Information Technology — Mobility
M.S. in Information Technology — Software Management
- **Mechanical Engineering**
B.S. in Mechanical Engineering
M.S. in Mechanical Engineering
M. of Product Development (jointly with the School of Design)
Ph.D. in Mechanical Engineering
- **Materials Science and Engineering**
B.S. in Materials Science and Engineering
M.S. in Materials Science and Engineering
Ph.D. in Materials Science and Engineering
- **West Coast Campus**
M.S. in Engineering and Technology Innovation Management
M.S. in Software Engineering
M.S. in Software Engineering — Development Management
M.S. in Software Management

College of Fine Arts

- **Interdepartmental**
M. of Arts Management (jointly with the H. John Heinz III School of Public Policy and Management)
- **Architecture**
B.Arch in Architecture (5 year program)
M.S. in Architecture–Engineering–Construction Management
M.S. in Building Performance and Diagnostics
M.S. in Computational Design
M.S. in Sustainable Design
M. of Tangible Interaction Design
M. of Urban Design
Ph.D. in Architecture
Ph.D. in Building Performance and Diagnostics
Ph.D. in Computational Design
- **Art**
B.F.A. in Art
M.F.A. in Art
- **Design**
B.F.A. in Communication Design
B.F.A. in Design
B.F.A. in Industrial Design
B.F.A. in Interaction Design
M. Design in Interaction Design
M. Design in Communication Planning and Information Design (jointly with Department of English)
M. of Product Development (jointly with Department of Mechanical Engineering)
Ph.D. in Design
- **Drama**
B.F.A. in Drama
M.F.A. in Costume Design
M.F.A. in Directing
M.F.A. in Directing and Playwriting
M.F.A. in Drama
M.F.A. in Dramatic Writing
M.F.A. in Lighting Design
M.F.A. in Production
M.F.A. in Production Technology and Management
M.F.A. in Scene Design
M.F.A. in Sound Design
- **Music**
B.F.A. in Music
B.F.A. in Music (Composition)
B.F.A. in Music Performance
M. Music in Composition
M. Music in Music Education
M. Music in Music Performance
M. Music in Performance

College of Humanities and Social Sciences

- **Interdepartmental**
B.S. in Economics and Statistics (jointly offered by Departments: Statistics and Economics)
B.A. in Ethics, History, and Public Policy (jointly offered by Departments: History and Philosophy)
B.A. in European Studies (jointly offered by Departments: Modern Languages and History)
B.S. in Ethics, History, and Public Policy (jointly offered by Departments: History and Philosophy)
B.S. in Information Systems
B.S. in Linguistics (jointly by offered by Departments: English, Modern Languages, Philosophy, and Psychology)
B.A. in Russian Studies (jointly offered by Departments: Modern Languages and History)
- **Center for the Neural Basis of Cognition**
Ph.D. in Neural Computation

- Economics (jointly with the Tepper School of Business)
 - B.A. in Economics
 - B.S. in Economics
 - M.S. in Quantitative Economics
 - Ph.D. in Economics
- English
 - B.A. in Creative Writing
 - B.A. in English
 - B.A. in Professional Writing
 - B.S. in Technical Writing and Communication
 - M.A. in Literary and Cultural Studies
 - M.A. in Professional Writing
 - M.A. in Rhetoric
 - M. of Communication Planning and Information Design (jointly with the School of Design)
 - Ph.D. in Literary and Cultural Studies
 - Ph.D. in Rhetoric
- History
 - B.A. in Anthropology and History
 - B.A. in History and Policy
 - B.A. in Social and Cultural History
 - B.S. in Anthropology and History
 - B.S. in History and Policy
 - B.S. in Social and Cultural History
 - M.A. in History
 - M.A. in History (fifth-year program along with Chatham College Secondary School Pennsylvania State Teacher Certification Program)
 - M.S. in History and Policy
 - Ph.D. in History
 - Ph.D. in History and Policy
- Modern Languages
 - B.A. in Chinese
 - B.A. in French and Francophone Studies
 - B.A. in German
 - B.A. in Hispanic Studies
 - B.A. in Japanese
 - Ph.D. in Second Language Acquisition
- Philosophy
 - B.A. in Philosophy
 - B.S. in Logic and Computation
 - M.A. in Philosophy
 - M.S. in Logic, Computation and Methodology
 - Ph.D. in Logic, Computation and Methodology
 - Ph.D. in Pure and Applied Logic (jointly with the Department of Mathematics and the School of Computer Science)
- Psychology
 - B.A. in Psychology
 - B.S. in Cognitive Science
 - B.S. in Psychology
 - B.S. in Psychology and Biological Sciences (jointly with the Department of Biological Sciences)
 - Ph.D. in Psychology
- Social and Decision Sciences
 - B.S. in Decision Science
 - B.S. in Global Politics
 - B.S. in Policy and Management
 - B.S. in Political Science
 - M.S. in Behavioral Decision Research
 - M.S. in Political Science
 - M.S. in Psychology and Behavioral Decision Research (jointly with the Department of Psychology)
 - M.S. in Social and Decision Sciences
 - Ph.D. in Behavioral Decision Research
 - Ph.D. in Political Science
 - Ph.D. in Psychology and Behavioral Decision Research (jointly with the Department of Psychology)
 - Ph.D. in Social and Decision Sciences
 - Ph.D. in Sociology
- Statistics
 - B.S. in Economics and Statistics (jointly with the Department of Economics)
 - B.S. in Statistics
 - M.S. in Statistics
 - Ph.D. in Statistics
 - Ph.D. in Statistics and Information Systems
 - Ph.D. in Statistics and Machine Learning (jointly with the Department of Machine Learning)
 - Ph.D. in Statistics and Public Policy (jointly with the H. John Heinz III School of Public Policy and Management)

Computer Science and Arts

- B. of Computer Science and Arts (jointly with the School of Computer Science and the College of Fine Arts)

Computational Biology

- M.S. in Computational Biology

Entertainment Technology Center

- M. of Entertainment Technology

The H. John Heinz III School of Public Policy and Management

- M. of Arts Management (jointly with the College of Fine Arts)
- M. of Entertainment Industry Management (jointly with the College of Fine Arts)
- M. of Medical Management
- M. of Public Management
- M.S. in Biotechnology Management (jointly with MCS and Tepper)
- M.S. in Educational Technology Management
- M.S. in Health Care Policy and Management
- M.S. in Information Security Policy and Management
- M.S. in Public Policy and Management
- Ph.D. in Public Policy and Management
- Ph.D. in Economics and Public Policy (jointly with the Tepper School of Business)
- Ph.D. in Statistics and Public Policy (jointly with H&SS)

Humanities and Arts

- B. of Humanities and Arts (jointly with the College of Humanities and Social Sciences and the College of Fine Arts)

Information Systems

- M. of Information Systems Management
- M.S. in Information Technology
- M.S. in Information Technology - Information Security and Assurance
- M.S. in Information Technology - Information Systems Management
- M.S. in Information Technology - Information Technology Management
- M.S. in Information Technology - Software Design and Management
- M.S. in Information Technology - Software Engineering (jointly with SCS)

Mellon College of Science

- Biological Sciences
 - B.A. in Biological Sciences (and a discipline the Humanities and Social Sciences)
 - B.S. in Biological Sciences
 - B.S. in Biological Sciences and Psychology (jointly with the Department of Psychology)
 - B.S. in Computational Biology
 - M.S. in Biological Sciences
 - M.S. in Computational Biology
 - Ph.D. in Biological Sciences
- Chemistry
 - B.A. in Chemistry
 - B.S. in Chemistry
 - B.S. in Chemistry/Computational Chemistry Track
 - M.S. in Chemistry
 - M.S. in Colloids, Polymers, and Surfaces (jointly with the Department of Chemical Engineering)
 - Ph.D. in Chemistry
- Mathematical Sciences
 - B.S. in Mathematical Sciences
 - B.S. in Computational Finance (jointly with Heinz School of Public Policy and Management and Tepper School of Business)
 - M.S. in Computational Finance (jointly with Heinz School of Public Policy and Management and Tepper School of Business)
 - M.S. in Algorithms, Combinatorics, and Optimization
 - M.S. in Mathematical Sciences

D.A. in Mathematical Sciences
 Ph.D. in Mathematical Finance
 Ph.D. in Mathematical Sciences
 Ph.D. in Pure and Applied Logic (jointly with the Department of Philosophy and the School of Computer Science)

- **Physics**
 B.A. in Physics
 B.S. in Physics
 M.S. in Physics
 Ph.D. in Applied Physics
 Ph.D. in Physics

School of Computer Science

B.S. in Computer Science
 M.S. in Algorithms, Combinatorics and Optimization
 M.S. in Computational Finance (offered jointly with the Tepper School of Business and the Heinz School of Public Policy and Management)
 M.S. in Computer Science
 M.S. in Computer Science (5th Year Scholars Program only)
 M.S. in Pure and Applied Logic (jointly with the Department of Mathematical Sciences and the Department of Philosophy)
 Ph.D. in Algorithms, Combinatorics and Optimization
 Ph.D. in Computer Science
 Ph.D. in Pure and Applied Logic (jointly with the Department of Mathematical Sciences and the Department of Philosophy)

- **Human-Computer Interaction**
 M.S. in Human-Computer Interaction
 M. of Human-Computer Interaction
 Ph.D. in Human-Computer Interaction
- **Institute for Software Research**
 M.S. in Information Technology — eBusiness Technology
 M.S. in Information Technology — Very Large Information Systems
 M.S. in Computation, Organizations and Society
 Ph.D. in Computation, Organizations and Society
- **Language Technologies Institute**
 M.S. in Language Technologies
 Ph.D. in Language Technologies
- **Machine Learning**
 M.S. in Knowledge Discovery and Data Mining
 M.S. in Machine Learning
 Ph.D. in Machine Learning
 Ph.D. in Machine Learning & Public Policy (jointly with the Heinz School of Public Policy and Management)
 Ph.D. in Computational and Statistical Learning
 Ph.D. in Statistics and Machine Learning (jointly with H&SS)
- **Robotics Institute**
 M.S. in Information Technology — Robotics Technology
 M.S. in Robotics
 Ph.D. in Robotics
- **Software Engineering**
 M. of Software Engineering
 M.S. in Information Technology
 M.S. in Information Technology (Software Engineering)
 M.S. in Software Engineering
 Ph.D. in Software Engineering

Science and Arts

B. of Science and Arts (jointly with the College of Fine Arts and the Mellon College of Science)

Science and Humanities Scholars

B.A./B.S. in various disciplines (jointly with the College of Humanities and Social Sciences and the Mellon College of Science)

David A. Tepper School of Business

B.S. in Business Administration
 M.B.A. in Industrial Administration
 M.S. in Accounting
 M.S. in Algorithms, Combinatorics, and Optimization (jointly with the School of Computer Science)
 M.S. in Civil Engineering and Management (jointly with the Carnegie Institute of Technology)
 M.S. in Computational Finance (jointly with the College of Humanities and Social Sciences, Mellon College of Science, and School of Computer Science)
 M.S. in Economics
 M.S. in Information Networking (jointly with the Carnegie Institute of Technology and the School of Computer Science)
 M.S. in Management, Manufacturing: Automation
 M.S. in Manufacturing and Operations Systems
 M.S. in Marketing
 M.S. in Operations Research
 M.S. in Organizational Psychology and Theory
 M.S. in Quantitative Economics
 M.S. in Software Engineering and Business Management (jointly with the School of Computer Science)
 Ph.D. in Accounting
 Ph.D. in Algorithms, Combinatorics, and Optimization (jointly with the School of Computer Science)
 Ph.D. in Economics
 Ph.D. in Financial Economics
 Ph.D. in Manufacturing and Operations Systems
 Ph.D. in Marketing
 Ph.D. in Operations Research
 Ph.D. in Organizational Psychology and Theory

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Undergraduate Admission

Michael A. Steidel, Director of Admission
Office: Warner Hall, Admission Lobby, First Floor

Admission Philosophy

At Carnegie Mellon, we select our freshman class from a large group of very qualified candidates. We don't use a calculation to arrive at our admitted class. Calculations can't take into account all of the factors we like to consider when making admission decisions. We treat every application individually and take great care in making our admission practices fair, thorough and sensitive. We are interested in students who can be successful at Carnegie Mellon and take full advantage of all the university has to offer and enriching our campus community.

Admission Criteria

The majority of our applicants are admissible and could be successful at Carnegie Mellon. We use a variety of factors to select our first-year class from those admissible candidates. High school performance weighs most heavily in our admission decision because it is the most meaningful measure of a student's abilities. We pay close attention to the type of courses taken and to the grades received, and to the challenges you've given yourself in the classroom. If you are applying to programs in the arts, your artistic performance will be either the main factor or a significant factor (depending on the program) in our admission decision.

Standardized test scores add to our knowledge of a student's ability, but we cannot make decisions simply on the basis of test scores alone. The high school record and standardized test scores (SAT Reasoning Test or Act with Writing and SAT Subject Tests) work together to make up the academic portion of a student's evaluation.

Carnegie Mellon is an exciting campus because of the positive qualities and experiences our students bring with them. For this reason, we're interested in the kinds of things students do beyond the classroom, whether they participate in extracurricular activities, work part-time or pursue hobbies. Knowing what students like to do on their own time gives us a feeling for each student's personality, motivation and sense of responsibility. All of this is an important part of the admission process.

Expressing an interest in learning more about Carnegie Mellon can only enhance a student's application. We strongly recommend that students come to the Carnegie Mellon campus to interview with a member of our staff, although it's not required. This adds a personal touch to our evaluation and gives students a chance to ask questions. If you cannot make it to campus, consider talking with a local Carnegie Mellon alumni representative. There are a number of other ways to show interest and learn more about Carnegie Mellon. Students can come to one of our Sleeping Bag Weekends, attend an information program in or near their town, interview in their hometown with one of our staff members or alumni, or enroll in one of our summer programs. Information about a number of these events is included at the end of this section.

Different Criteria for Different Colleges

Each college at Carnegie Mellon has special admission criteria specifically related to each course of study.

Admission to the Schools of Drama and Music is based primarily on an audition or portfolio showing. Applicants to the Schools of Art and Design will be evaluated not only on the basis of their portfolio but also on their academic performance. Students applying to the School of Architecture will have to complete an online questionnaire and have the option to submit creative work for review, in addition to having their academic performance evaluated.

Candidates for the Carnegie Institute of Technology, the Mellon College of Science, and the School of Computer Science will be evaluated on the basis of academic performance, and we will look additionally for strength in mathematics and science. Academic performance is also the main criteria we use to evaluate applicants to the College of Humanities and Social Sciences, the Information Systems program and to the Tepper School of Business' undergraduate program. In these cases, we emphasize reading and comprehension abilities as well as mathematics courses.

No one single grade, factor or score will automatically grant or deny a student admission to Carnegie Mellon. Students should be aware of all the admission requirements—secondary school preparation, standardized test requirements, nonacademic information, counselor, teacher and interview recommendations—when submitting applications. We will use the sum total of these different factors when making our admission decisions. Because we want to have a sense of who the student is as a person, we look closely at the essay and personal statement the student is asked to write, the guidance counselor's evaluation and the teacher's recommendation.

Freshman Application Instructions

Carnegie Mellon uses the Common Application exclusively. Before your Common Application will be processed, you must submit the Carnegie Mellon Common Application Supplement.

- Apply for admission to the specific college(s) in which you are interested.
 - Indicate college and/or major by checking proper box on Carnegie Mellon Common Application Supplement.
- If applying to more than one college or program, please rank your choices.
 - You do not have to submit two applications, and there is no additional cost. Simply indicate on the Carnegie Mellon Common Application Supplement the colleges to which you are applying.
 - Make sure to meet the admission requirements for each college or department.
- Follow these guidelines for your specific area of interest:
 - Carnegie Institute of Technology (CIT)
 - College of Humanities and Social Sciences (H&SS)
 - Information Systems (IS)
 - Mellon College of Science (MCS)
 - School of Computer Science (SCS)
 - Tepper School of Business (Tepper)
 - Bachelor of Humanities and Arts (BHA) – see "Intercollege Degree Programs"
 - Bachelor of Science and Arts (BSA) – see "Intercollege Degree Programs"
 - Bachelor of Computer Science and Arts (BCSA) – see "Intercollege Degree Programs"

We strongly urge you to indicate a program preference at the time you apply. Although you won't declare a major until the end of your freshman or sophomore year (in some cases), Carnegie Mellon limits access to certain majors, including Electrical and Computer Engineering, Computer Science and Business.

College of Fine Arts (CFA): You must apply specifically to one of the following schools: Architecture, Art, Design, Drama or Music. (See specific instructions to follow.)

- Enclose with your application the non-refundable \$70 application fee (and audition fees if applicable) as specified in our application packet.

We require this fee of all applicants except in extenuating family financial circumstances. A College Entrance Examination Board Application Fee Waiver, an ACT Application Fee Waiver, or a letter from a secondary school counselor or principal requesting an application for a waiver must be submitted.

If you are applying to the School of Music, the additional audition fee is \$50 and if you are applying to the School of Drama the additional audition fee is \$80 and only payable online, at the time of registration. Please see www.cmu.edu/admission/finearts for more details.

5. Plan to visit our campus or interview with a Carnegie Mellon alumnus, if possible. (See section on "Experience Carnegie Mellon.")
6. Send all of your high school transcripts to the Office of Admission. An updated transcript, which includes senior year courses and midyear grades, must be submitted as close to January 1 as possible. The Office of Admission does not acknowledge receipt of these items. We do not confirm fax or FedEx materials for up to 48 hours during our peak times. However, by about March 1 we will let students know if something is missing.
7. Take the SAT Reasoning Test or ACT with Writing preferably by December. In most disciplines, you must also take two SAT Subject Tests by December. (If you are applying to art, design, drama or music, SAT Subject Tests are not required.)
 - Scores must be official scores from the Educational Testing Service (ETS). Copies should not be sent. When registering for the tests, request that an official CEEB Report be sent directly to Carnegie Mellon. This request can also be made later by getting an Additional Report Request Form from your guidance office. The Carnegie Mellon code number is 2074.
 - Register for your tests at least six weeks prior to the test date.
8. The Test of English as a Foreign Language (TOEFL) or the International English Language Testing System (IELTS) should be taken if your native language is not English and your SAT Critical Reading score is less than 600. Carnegie Mellon requires CBT TOEFL scores of 250 or better, 600 or better on the pencil and paper TOEFL, IBT TOEFL score of 100 or better and IELTS scores of 7 and above.
9. If you are applying to the College of Fine Arts Schools of Architecture, Art, Design, Drama or Music, you must complete the portfolio, questionnaire or audition requirements. Before you can arrange an audition or review at <www.cmu.edu/admission/finearts>, your application and supplement must be submitted by December 1 (November 1 for Early Decision), except for Drama which follows the January 1 admission deadline.
10. You must sign the "Confidentiality Statement" on the Secondary School Report and give it to your secondary school counselor for completion. Your counselor should return this form, along with the application, directly to the Office of Admission, as soon as possible.
11. Complete Part I of the Teacher Evaluation and give it to a teacher to complete. You should also provide your teacher with an addressed, stamped envelope to return the form to Carnegie Mellon's Office of Admission by January 1.
12. The application deadline is January 1. The student or counselor should be sure to return the application and supplement, Secondary School Report and complete transcripts by this date.

IMPORTANT: Carnegie Mellon prefers that all forms and documents be submitted at the same time. If they must be sent separately, student should be sure to print full name and social security number at the top of each document.
13. If you are applying for financial aid, complete a Free Application for Federal Student Aid (FAFSA) at www.fafsa.org. Send a copy of your completed FAFSA directly to Carnegie Mellon. Carnegie Mellon's Title IV code is 003242. You must also complete a Carnegie Mellon Financial Aid Application, and submit signed copies of parent and student tax documents. See www.cmu.edu/admission for more details.

Application Notification

- Students applying under the Early Decision I Plan will be notified of our decision by December 15.
- Students applying under the Early Decision II Plan will be notified of our decision by January 15.
- Students applying under the Regular Decision Plan will be notified of our decisions by April 15.
- Students who are applying for financial aid will also receive financial aid decisions by April 15 provided they submitted their financial aid forms by the preferred financial aid deadline of February 15.

If you are offered admission and wish to enroll at Carnegie Mellon, you are required to pay a \$600 non-refundable enrollment deposit by May 1 (Candidate's General Reply Date), even if you are receiving financial aid, in order to reserve places in the freshman class and in university housing. This deposit will be credited to your first semester's charges. The admission staff assumes that a student's deposit to Carnegie Mellon is his or her only deposit. We reserve the right to cancel our offer of admission if a student posts a tuition deposit at another university. During the summer, information concerning registration, enrollment, insurance, orientation, housing and dining services, etc., will be sent to all students.

Deferred Admission

If you are admitted to Carnegie Mellon and wish to defer your admission for one year, you must submit a request in writing to the Office of Admission. If permission is granted, your enrollment deposit must be paid in order to confirm enrollment for the following year. You cannot enroll in a degree program at another institution in the interim.

Application Plans

Early Decision Plans

If Carnegie Mellon is your first choice, you may want to consider applying Early Decision. Under this plan, applicants are notified of our admission decision early in the senior year. If you are accepted Early Decision, we expect you to enroll in Carnegie Mellon. Under the Early Decision plans, we encourage you to submit applications to other schools. However, if you are accepted to Carnegie Mellon, we require you to withdraw your applications from other schools.

Carnegie Mellon will meet the full demonstrated need with a combination of grants, loans and workstudy as calculated by the university for all students admitted under early decision. However, we do not guarantee to meet full need for students who are deferred or denied admission under Early Decision and later admitted under Regular Decision.

Early Decision I is available to all programs, with the exception of drama or BCSA/BHA/BSA. Early Decision II is available to all programs, with the exception of architecture, art, design, drama, music or BCSA/BHA/BSA. If you'd like to apply through an Early Decision plan:

1. Check the appropriate box on the application supplement.
2. If you are applying under Early Decision I, submit your application by November 1 of your senior year. (Please note there is no Early Decision option for Drama or BCSA/BHA/BSA.)
3. If you are applying under Early Decision II, submit your application by December 1 of your senior year. (This option is not available to fine arts applicants or BCSA/BHA/BSA.)
4. Submit all forms and credentials that are available (high school transcript, SAT Reasoning Test or ACT with Writing results, SAT Subject Test results), preferably by November 1 of your senior year (for Early Decision I) or by December 1 (for Early Decision II) of your senior year.
5. Arrange to have a campus visit that includes a group information session or an interview with a member of the admission staff, if possible.
6. Fulfill the portfolio, audition or questionnaire requirements if applying to the College of Fine Arts.

Early Decision applicants will be notified of our admission decision by December 15 (Early Decision I) or January 15 (Early Decision II). If you are admitted under Early Decision, you are required to withdraw all admission applications to other colleges or universities and post a non-refundable enrollment deposit of \$600 within two weeks of your admission notification.

Regular Decision Plan

Regular decision is our most popular application option. The deadline is January 1 (December 1 for fine arts, except for Drama). You will be notified of our decision by April 15. Admitted students will have until May 1 (Candidate's General Reply Date) to accept our offer of admission.

Early Admission

Through the process of Early Admission, the university admits certain highly qualified applicants at the end of their junior year in high school. In general, Early Admission candidates are highly mature and responsible students who have usually exhausted the courses offered at their high schools without receiving a high school diploma. We expect students who apply for early admission to follow the same procedures as regular freshman applicants. We also strongly encourage applicants to have a personal interview with a member of the Office of Admission staff. It is important to note that the College of Fine Arts very rarely accepts Early Admission applicants.

Transfer Applicants

Transfer students are admitted to Carnegie Mellon under policies which vary from college to college. In order to transfer to the Carnegie Institute of Technology, the School of Computer Science, the Mellon College of Science or the Tepper School of Business there must be space available in the particular department to which you are applying. If there is space in the requested program, we will base our decision on your college grades, college recommendations, high school grades and test scores (SAT Reasoning Test or ACT with Writing and SAT Subject Tests, if available). In the College of Fine Arts, most transfer applicants compete with freshman applicants for a place in the entering class.

Transfer Application Instructions

1. Apply for admission to the specific college of interest, noting departmental preference. If interested in music or drama, student should specify the option. Transfer students will be considered only to their first-choice college. Please do not apply to more than one college.

CIT, H&SS, IS, MCS, SCS and Tepper:

- Fall transfer possible if space is available
- Spring transfer extremely limited and unlikely
- No external transfers accepted into BCSA/BHA/BSA

CFA:

- Fall transfer possible
- No spring transfer opportunities (except for advanced students in the School of Music)
- If you're interested in the School of Music or Drama, specify the option
- No external transfers accepted into BCSA/BHA/BSA

2. Enclose a non-refundable fee of \$70 (and audition fees if applicable). This application fee is required, except in extenuating family financial circumstances. To request a waiver, student should send us a letter from a college advisor or dean requesting an application fee waiver in place of the application fee. Make all checks or money orders payable to Carnegie Mellon University. Do not send cash. If applying to music, the additional audition fee is \$50 and if applying to drama, the additional audition fee is \$80. Submit all fees with your application.
3. Send all transcripts that reflect secondary school and college/university studies to the Office of Admission. Include a catalog (labeled with your name) and highlight course descriptions from each college/university attended, or provide us with links to your college's online catalog/specific courses within the catalog.

IMPORTANT: If you have applied to Carnegie Mellon within the past three years, you must resubmit an updated application with fee (and audition fee if appropriate) and all other materials required of transfer students. You do not have to submit high school records.

4. If you are applying to the Schools of Architecture, Art, Design, Drama or Music, you must complete the portfolio, questionnaire or audition requirements. You must complete and submit the application for admission by December 1, except for Drama which follows the January 1 deadline.
5. Sign the "Confidentiality Statement" on the Secondary School Report. Give this form and your completed application for admission to a dean or an advisor at the

college you attended (or are currently attending). Your dean or advisor should complete and return the form and application directly to the Office of Admission.

IMPORTANT: Carnegie Mellon prefers that all forms and documents be submitted at the same time. If they must be sent separately, make sure to print your full name and social security number at the top of each document.

6. Transfer application deadlines are as follows:
 - Spring transfer: November 1
 - Fall transfer: March 1 (December 1 for CFA applicants, except for Drama)
7. If you are applying for financial aid, complete a Free Application for Federal Student Aid (FAFSA) at www.fafsa.org. Complete the form and return it to the appropriate federal processor listed in the FAFSA instructions. Send a copy of your completed FAFSA directly to Carnegie Mellon. Carnegie Mellon's Title IV code is 003242.

If planning on:	File FAFSA by this date:
Spring transfer	November 1
Fall transfer (CFA)	February 15
Fall transfer (all other colleges)	May 1

IMPORTANT: If you are applying for financial aid as a transfer student, you must send a Financial Aid transcript of aid applied for and/or received at all colleges previously attended. Even if you didn't receive any aid, federal regulations require that the college(s) attended complete the form.

Admission and financial aid award notification dates for transfer students:

Spring transfer:	December 15 or soon after
Fall transfer (CFA):	April 15
Fall transfer (all other colleges):	During month of June

8. Make arrangements to have a final copy of your college transcript(s) sent to Carnegie Mellon.

Deposit Information for Transfers

If you are offered admission for the spring semester, Carnegie Mellon does not require a tuition deposit (due to the short time interval between December 15 and the start of the second semester). If you are offered admission to the College of Fine Arts for the fall semester, you must pay a non-refundable deposit of \$600 by May 1, even if you are receiving financial aid. If you are offered admission to CIT, H&SS, IS, MCS, SCS or TEPPER for the fall semester, you must pay a non-refundable \$600 deposit by June 15, even if you are receiving financial aid. The enrollment deposit will reserve your place at the university and a place in university housing if available. It will be credited to the first semester charges.

IMPORTANT: If you accept our offer of admission, Carnegie Mellon assumes that the tuition deposit to Carnegie Mellon is your only tuition deposit. We reserve the right to cancel our offer of admission if you post a tuition deposit at more than one university. Enrollment deposits received after the deadline may be returned if space is no longer available.

University Housing for Transfers

Carnegie Mellon expects to accommodate most transfer students who request university housing. University housing is not guaranteed, however, for transfer students. The Off-campus Housing Advisory and Referral Service is available to help you locate housing accommodations in the local area.

Transfer Credit Evaluated on Individual Basis

Carnegie Mellon's departmental faculty will determine transfer credit for courses you've taken at other universities. Transfer credit is considered on an individual basis. We may award elective credit for courses with no Carnegie Mellon equivalent. In some instances, the College Council may recommend a special program of study for you to meet the university's graduation requirements.

Transfer credit for courses you are taking while we review your existing college record depends upon successful completion of each course. Grades are not transferred — only credit is. You may receive transfer credit for elective courses you've taken but will still have to take Carnegie Mellon courses to fulfill the elective space in your chosen degree program. Sometimes transfer students have

to take specific courses and accumulate a larger total number of credits than the normal amount required for graduation. The time it takes for you to graduate will depend on the time you need to complete the full university degree requirements — not on class standing at a previous institution.

If you transfer into CIT, IS, MCS, SCS or Tepper in the fall semester, you will receive an estimate of the additional academic work that you must complete in order to fulfill the university degree requirements. If you transfer into CIT, IS, MCS, SCS or Tepper in the spring semester, you will have the opportunity to meet with a dean or department head in order to outline the additional academic work that you must complete in order to meet the university degree requirements. If you transfer into H&SS in the fall or spring semester, you'll receive a credit and requirement review of the work you've completed at your previous institution(s). It is best for transfer students in CFA to assume freshman status. Occasionally advanced standing is awarded based on review of previous college courses.

Application as an International Student

International students should apply to Carnegie Mellon using the same procedures outlined for either freshmen or transfer students. Also note this additional information:

- Before submitting the Common Application and Carnegie Mellon Supplement, and other application materials, please submit the Preliminary Application for International Students and return it to the Office of Admission. Because Carnegie Mellon does not offer financial aid to international students, we use this application to verify each student's ability to pay for a Carnegie Mellon education. If you have access to the Web, you can find the Preliminary Application online. International students are not eligible for application fee waivers.
- If your native language is not English and your SAT Critical Reading Test score is less than 600, you are required to take the Test of English as a Foreign Language (TOEFL) or the International English Language Testing System (IELTS). Carnegie Mellon requires TOEFL scores of 250 or better on the CBT TOEFL, 600 or better on the pencil and paper TOEFL, 100 or better on the IBT TOEFL or an IELTS score of 7 and above. Please arrange to have these scores sent no later than January 1.
- Financial aid and installment payment plans are unavailable to international students.

Secondary School Preparation and Required Tests

College	High School Preparation	Tests ⁵
Carnegie Institute of Technology (CIT) Mellon College of Science (MCS) School of Computer Science (SCS) David A. Tepper School of Business (Tepper)	4 years English 4 years Mathematics ¹ 1 year Chemistry 1 year Physics 1 year Biology 2 years Foreign Language 3 electives	SAT Reasoning Test or ACT with Writing SAT Subject Tests (2) Math Level I or II Physics, Chemistry or Biology ⁴ Prospective students may take any second test, but preferably a science.
College of Humanities and Social Sciences (H&SS) Information Systems (IS)	4 years English 3 years Mathematics ² – H&SS applicants 4 years Mathematics ¹ – IS applicants 1 year Science (2 or more years preferred) 2 years Foreign Language 6 electives	SAT Reasoning Test or ACT with Writing SAT Subject Tests (2) Math level I or II One additional test
School of Architecture	4 years English 3 years Mathematics ¹ 1 year Physics 2 years Foreign Language 5 electives	SAT Reasoning Test or ACT with Writing SAT Subject Tests (2) Math level I or II Physics or Chemistry
School of Art School of Drama School of Music	4 years English 2 years Foreign Language 10 electives ³	SAT Reasoning Test or ACT with Writing
School of Design	4 years English 2 years Mathematics 2 years Science 2 years Foreign Language (preferred) 6 electives	SAT Reasoning Test or ACT with Writing

¹ The four years of mathematics should include, *at least*: algebra, geometry, trigonometry, analytic geometry and elementary functions (pre-calculus).

² For H&SS applicants, three years should include *at least*: algebra, geometry and trigonometry.

³ For School of Music applicants, some prior Solfege is helpful.

⁴ The Biology SAT Subject Test is not acceptable for CIT applicants.

⁵ Only junior or senior year test results are acceptable.

While a high school diploma is not required for admission to Carnegie Mellon, it is to your advantage to make arrangements to eventually receive one. Consult your high school for more advice, or for special arrangements, contact your state Board of Education for information about the General Education Diploma (GED).

Advanced Placement Consideration

CEEB Advanced Placement Program

Carnegie Mellon recognizes the CEEB Advanced Placement program and may grant advanced placement and credit for test scores of four or five. We encourage eligible students to take the AP examinations. We will receive the test scores in early summer for those students who have requested that their results be sent to Carnegie Mellon. The appropriate academic deans will evaluate your scores, and in late summer, you will be informed of the AP credit awarded.

College Level Course Work

The university may also award placement and credit for college work completed during high school. Applicants who have taken college courses should arrange to have their college transcripts along with course catalogs or descriptions sent to the Carnegie Mellon Office of Admission for transfer credit evaluation and advanced placement.

International Baccalaureate Program

Carnegie Mellon also recognizes the International Baccalaureate Examination and may grant advanced standing and/or credit in various fields if scores on the higher level examination range from six and seven. The results of the IB exams should be sent to Carnegie Mellon, where the appropriate dean will evaluate the scores. In late summer, you will be notified of the credit that has been awarded.

Intercollege Degree Programs

Bachelor of Computer Science and Arts (BCSA)

The Bachelor of Computer Science and Arts (BCSA) Program is an intercollege degree-granting program. It is designed for students who would like to combine their interests in the fine arts and computer science rather than pursue a conventional major and degree in either the College of Fine Arts or the School of Computer Science. To be considered for the BCSA program, you must apply and be admitted to both CFA and SCS (you must check the CFA box and SCS box on the Carnegie Mellon Common Application Supplement). This program is not open to music theatre, acting, directing, drama design, dramaturgy, music performance, or music, history and culture majors. Not all students admitted to both colleges are selected for the BCSA program.

Bachelor of Humanities and Arts (BHA)

The Bachelor of Humanities and Arts (BHA) program is an intercollege degree-granting program. It is designed for students who would like to combine and blend their interests in fine arts and humanities/social sciences rather than pursue a conventional major and degree in either the College of Fine Arts (CFA) or the College of Humanities and Social Sciences (H&SS). To be considered for the BHA program, a student must apply and be admitted to both CFA and H&SS (you must check the CFA box and H&SS box on the supplement). This program is not open to music theatre, acting or voice majors. Not all students admitted to both colleges are selected for the BHA program.

Bachelor of Science and Arts (BSA)

The Bachelor of Science and Arts (BSA) program is an intercollege degree-granting program. It is designed for students who would like to combine studies in both the fine arts and natural sciences/mathematics rather than pursue a conventional major and degree in either the College of Fine Arts (CFA) or the Mellon College of Science (MCS). To be considered for the BSA program, a student must apply and be admitted to both CFA and MCS (you must check the CFA box and MCS box on page 3 of the supplement). This program is not open to music theatre, acting or voice majors. Not all students admitted to both colleges are selected for the BSA program.

With the BCSA/BHA/BSA programs, you must include with your application a statement of intent (essay) describing your interdisciplinary goals in both academic areas and how the BCSA/BHA/BSA program would provide the opportunity and framework for you to accomplish these objectives. This essay is a central component in the selection process. The BCSA/BHA/BSA statement of intent fulfills the essay requirement on the supplement. You do not need to complete another essay. If you are selected for this program, you will be notified in your admission decision letter. These programs are not available under Early Decision.

College of Fine Arts Requirements

If you are applying to the Schools of Architecture, Art, Design, Drama or Music within the College of Fine Arts:

- You must submit your application and supplement by December 1 for Regular Decision, except for drama which follows the January 1 deadline or November 1 for architecture, art, design and music Early Decision consideration, or the November drama audition.
- You must go to www.cmu.edu/admission/finearts to register for an audition or portfolio review, or to complete the required online questionnaire for the School of Architecture.
- Expect to receive instructions from us via email regarding your audition/review as soon as you register online.
- Do not expect a final admission decision at the time of your audition/review; we'll consider the results of audition/review along with your other credentials and notify you by April 15 (January 15 for Architecture, Art, Design and Music Early Decision applicants).

School of Architecture Admission Procedure

The study of architecture at Carnegie Mellon is an exciting, multidisciplinary activity that synthesizes design creativity, social responsibility, historical perspective, technical competence and global environmental consciousness. The five-year curriculum leads to an accredited professional Bachelor of Architecture (B.Arch) degree and a broad range of career opportunities.

The School of Architecture is seeking students with diverse backgrounds, interests and creative potential, as well as a distinct passion for architecture in all its many facets. We have found that successful architecture students have a variety of qualifications, including:

- Academic Record - as demonstrated by secondary school transcript, class rank, SAT Reasoning Test or ACT with Writing scores, and two SAT Subject Tests, including Math, and either Physics or Chemistry.
- Creative Ability - as demonstrated by a portfolio of creative work (see following details), as well as other artistic endeavors based on innovation and synthesis.
- Interpersonal and Leadership Skills - as demonstrated by awards and honors, extracurricular activities, letters of recommendation, service and a personal statement.

Because the possibilities of studying architecture in high school can be limited, we encourage all applicants to make every effort to develop an understanding of what it means to study architecture - inquire how architecture is different from engineering, art and other fields, and seek to understand the unique strengths of Carnegie Mellon's architecture program. To determine your sincere interest in architecture, and to measure the potential for success in the School of Architecture, we encourage you to:

- Participate in one of the many summer programs offered by schools of architecture in the United States and abroad. Carnegie Mellon offers a summer pre-college program that introduces and tests your interest and ability in architecture. The Pre-College program offers opportunities to socialize with students from around the country, become familiar with the campus and city, and experience first-hand the life and studies of an architecture student. For more information about our Pre-College program, visit our website at www.cmu.edu/enrollment/pre-college.
- Visit architecture schools (while courses are in session) at every college you are seriously considering. Be sure to visit the design studios and talk to enrolled students and faculty to understand both the nature of the academic program and the unique life of an architecture student. Seek to understand the unique strengths and character of each program.
- Pursue a variety of rigorous architectural and artistic opportunities while in high school such as working in an architect's office, on a construction site or in a planning office; attend art classes and read about historical as well as contemporary architecture.
- Take the highest-level courses available at your high school in: art (a variety of media); history (courses in western and non-western history); English (advanced literature); mathematics (calculus) and science (Physics).

Questionnaire Submission

All applicants to the School of Architecture are required to complete an online questionnaire by the January 1 questionnaire deadline (November 1 for Early Decision applicants). The questionnaire is available for completion at <www.cmu.edu/admission/finearts>.

Portfolio of Creative Work

In addition to completing the admission application and supplement, and required online questionnaire, students are highly encouraged to submit a portfolio of creative work to the School of Architecture as a first option. Moreover, an on-campus review of your portfolio of creative work is the preferred option and most highly recommended.

The School of Architecture believes in the value of personal contact to ensure the success of admission decisions. In general, everyone is best served by an on-campus visit to both the Office of Admission and the School of Architecture to get to know the university and School of Architecture, as well as the faculty and students. After completing the required online questionnaire for the School of Architecture, we highly recommend that you submit an optional portfolio of creative work and if possible, schedule an on campus portfolio review. If you are unable to submit a portfolio or arrange personal contact with the School of Architecture, your admission application will be reviewed along with the other applicants, without prejudice. You can sign up for an on-campus review of your portfolio of creative work at www.cmu.edu/admission/finearts. Generally, on-campus reviews are held in January and February, but Early Decision applicants have a session reserved for mid-November.

Portfolio Objectives

We are interested in understanding your creativity in all its facets: compositions, creations and inventions. As a result, we encourage you to submit a variety of creative works that demonstrate your innovative ideas, spatial reasoning, visual thinking and your desire to make and build things. Your portfolio is intended to expose your ability to analyze, problem-solve, think critically, and synthesize. We are interested in determining your commitment and motivation to study architecture. Keep in mind that the architecture professors who will review your portfolio are much more interested in understanding your creativity intent and design process than your mastery of specific skills or techniques. For this reason, you should avoid submitting drafting work as part of your portfolio of creative work.

Portfolio Assembly

We suggest that you think strategically about how you communicate and present your potential success as a student of architecture. We advise you to consider the process of assembling and submitting your creative work as a design project: how can you best present your abilities, interests and passion through your creative work? Select projects that show a range of media and subject matter while still emphasizing your strongest work. Please submit final and completed works for review, not works in progress.

Portfolio Format

The portfolio of creative work must be well organized and conform to the following standards:

Size: fixed dimensions of 8.5" x 11" single-sided pages, all vertically oriented or all horizontally oriented.

Quality: All work must be high quality photographs, photocopies or prints. DO NOT MAIL ORIGINAL WORK, CD/DVDs OR SLIDES.

Length: Your portfolio will consist of 12 total pages (10 pages of actual creative work).

Page 1: Cover page includes your name, address, email and telephone number(s).

Page 2: Contents page includes for each of the 10 works, a title, original size, date, media and maximum 20 word description. Indicate whether the work was done for a class, collaboratively or independently.

The remaining 10 pages of your portfolio will showcase creative works of your choice. Some examples only of potential submissions include, but are not limited to the following:

Freehand drawing: These must be original works from life or your imagination, therefore, no reproductions. Sketchbook pages scanned to one or more pages is strongly recommended.

2-D design such as collage, digital work, graphics, painting, photography, printmaking, etc. Work should not be copied from an image you found, nor should they be simply an assignment in a technical drafting class.

3-D design such as architectural models, ceramics, furniture, textiles, metalwork, sculpture, woodwork, etc. Use proper lighting techniques to document and present your 3-D work.

Other works of your choice such as artistic/graphic interpretations of music and/or performance, literature (poetry, prose, script), etc.

For more information on assembling your portfolio of creative work, visit www.cmu.edu/admission/finearts and select the School of Architecture section.

Portfolio Submission and Review (optional)

Submission of a portfolio of creative work is highly recommended, although **optional**. All portfolio submissions must be mailed directly to the School of Architecture by the January 15 portfolio submission deadline (November 1 for Early Decision applicants). Portfolios must follow all formatting guidelines, which may be found at <www.cmu.edu/admission/finearts>. All applicants submitting the portfolio of creative work must register for one of two options for the portfolio of creative work to be reviewed: either mail-in review or on-campus review.

How to Register for a Portfolio Review: All applicants who are submitting a portfolio must visit <www.cmu.edu/admission/finearts> to register for one of two options for the portfolio of creative work to be reviewed by the school: either mail-in review or on-campus review. The registration deadline for all portfolio reviews is January 1. Applicants selecting the mail-in review will submit their portfolios to the School of Architecture for evaluation. Additionally, registering for an on-campus portfolio review is highly recommended. Those applicants selecting the on-campus review option will also submit their portfolio to the school and register for an appointment to visit the Carnegie Mellon campus for in-person portfolio review with School of Architecture faculty. The personal review will involve inquiry, critique and interactive discussion with Architecture faculty. Appointments are limited, so please register as soon as possible.

When and Where to Submit Your Portfolio of Creative Work: All portfolios of creative work, regardless of review option, are to be mailed directly to the School of Architecture and postmarked by January 15 (November 1 for Early Decision applicants). Those applicants who register for the on-campus portfolio review option will receive their previously submitted portfolio of creative work at the time of their review. Write your name on all materials. If you want us to return your portfolio, please include a self-addressed, postage-paid envelope or container. Mail all portfolios of creative work to:

School of Architecture
Portfolio or Creative Work Review
College of Fine Arts 201
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213-3890

Contact

If you have any questions about the architecture admission process, the online questionnaire or the submission of creative work, please contact Alexis McCune, Coordinator of Student Programs in the School of Architecture by email at <amccune@andrew.cmu.edu>.

Transfer Students

Transfer applicants to the School of Architecture are classified as freshmen and will begin the program in the first year.

National Portfolio Days

The School of Architecture does not participate in National Portfolio Days. The school evaluates all portfolios and invites you to register your portfolio for a review to be held on campus. Please contact the school with any questions about your portfolio or creative work.

School of Art Admission Procedure

The Carnegie Mellon School of Art seeks students with a wide range of talents, aptitudes and backgrounds. Artistic ability, academic performance and leadership capabilities are all important factors. These capabilities are evaluated through a review of a portfolio of creative work, high school grades, standardized test scores, extracurricular activities, recommendations and personal statements. All applicants are considered for fall semester admission only.

Transfer applicants must complete all admission requirements, including the portfolio review. Transfer students should expect to have freshman status for at least the first semester at Carnegie Mellon School of Art. Transfer credit is evaluated after the applicant has studied at Carnegie Mellon School of Art for a period of time.

The Art Portfolio

The School of Art offers two ways for applicant work to be reviewed—an on-campus review or an online review.

The portfolio should be assembled to showcase your engagement with materials, ideas and contexts. Pieces that show your ability to work on a wide range of artistic concerns, or to work in depth and in sequence on a single idea, are desirable. The portfolio should include as much work as possible done independently and outside of the classroom.

The School of Art faculty is just as interested in an applicant's creative thinking skills as in his/her technical skills. We want to see whatever you have made that is personal, unique and unusual... that thing you have been working on that may be so crazy and interesting that you are not even sure it's art...that project so ambitious and awkward that it could not have been made by anyone else but you.

The Art Portfolio is only one part of the application, thus the score of the portfolio review is not disclosed to the applicant. Applicants receive notification of the status of their overall application after all components have been evaluated and the admission decision has been made.

The portfolio should include pieces from as many of the following categories as appropriate:

- Sculpture in any medium or any size.
- Environmental or site-specific installation (work made for a particular location either indoors or outdoors).
- Drawings and paintings, done from observation and/or imagination.
- Photography, printmaking projects, collage, mixed media, etc.
- Computer-generated imagery.
- Work that changes with time, such as kinetic sculpture, animation, installation, digital video, actions and performance, including live action video and interactive work or other time-based works.

The On-Campus Portfolio Review

Applicants may bring their portfolio to campus on one of the Sunday On-Campus Portfolio Review Days. On-Campus Portfolio Review Days offer an opportunity to attend group information sessions, meet individually with an art faculty member, and take a tour of School of Art facilities. In order to attend an on-campus portfolio review, applicants must submit their application and supplement by: November 1, (early decision) or December 1, (regular decision and transfer students). All arrangements for attending the on-campus portfolio review days should be done through the Office of Admission at www.cmu.edu/admission/finearts.

You must pre-register for an on-campus portfolio review. Please go to www.cmu.edu/admission/finearts for dates and availability. We honor review appointments on a first-come, first-served basis. Please register as soon as possible to secure a review appointment. The Office of Admission will send you a confirmation email when you register online. If the confirmation does not arrive two weeks prior to your review, call the Office of Admission at 412-268-2082 to confirm. If attending an on-campus portfolio review day, an applicant should not submit a portfolio online.

What To Bring For The On-Campus Art Portfolio Review

Applicants should bring 15-20 recent art works to their On-Campus Portfolio Review Day. Applicants can bring any of the following work for the on-campus review:

- Actual two-dimensional work such as drawings, paintings, prints, etc. (Matting and mounting of works is not necessary. It is highly recommended to apply fixative to works that smudge.)

- Actual three-dimensional work such as sculpture, ceramics, glass, textiles, etc.
- A sketchbook, illustrated journal, etc. (each of these is considered one item).
- Photographs, slides or other documentation of work, which because of its size, weight or other circumstances, cannot be transported to the review. Examples: a large sculpture, a mural or other piece permanently installed, a work no longer owned by the applicant, or a piece under consideration for an award.
- Work submitted on a CD or DVD. Examples:
 - a) Computer graphics: JPEG or TIFF format, 1024x768 maximum image size.
 - b) Time-based work: Video on DVD; Animations must be composited to play on DVD or as a Quicktime movie.
 - c) Interactive work. Must run as a stand-alone application, without requiring the installation of additional software.
 - d) Web site.

Online Portfolio Review

The School of Art accepts portfolios via online submission. Applicants can upload, label, arrange and submit their portfolios electronically. In order to submit your portfolio online, please go to www.cmu.edu/admission/finearts to register and submit your portfolio.

Applicants submitting a portfolio online should not also attend an on-campus portfolio review day. As with on-campus reviews, all online portfolio items are evaluated by art faculty. While an on-campus portfolio review brings obvious advantages to the applicant, there is no penalty for submitting a portfolio online.

The online art portfolio must contain the items listed below:

1. Documentation of 15-20 recent art works submitted as follows:
 - a) Images of paintings, prints, drawings, sculpture, computer-generated imagery.
 - b) Time-based work such as video, animation, performance.
 - c) Interactive work or a web site. (If you have media that cannot be accommodated by the system, please contact the School of Art at 412-268-2409 for instructions on how to submit additional media.)
2. Completion of two short-answer essays. (Questions available on SlideRoom.)

Tips for Documentation of Work

- The work should be photographed so that the image fills the frame.
- A neutral background is recommended so that it does not conflict with the work.
- If several exposures of each piece are taken with different camera settings, the applicant will be able to select the best one for use in the portfolio.

Off-Campus Portfolio Critiques/National Portfolio Days

Carnegie Mellon participates in National Portfolio Days throughout the United States. Art faculty attending selected National Portfolio Days will provide informal portfolio critiques for those considering application. Please see www.cmu.edu/admission/finearts for dates and locations. A National Portfolio Day critique does not satisfy the formal portfolio review process required for admission.

School of Design Admission Procedure

The School of Design is seeking a class of students with a wide range of backgrounds, creative talents and interests. We have found that successful design students have a variety of qualifications. We look closely at students' qualifications in the following three categories:

- Academics: academic performance and curriculum, SAT Reasoning Test or ACT with Writing scores.
- Visual and design ability: portfolio and design project (see details below).
- Interpersonal skills: as demonstrated through extracurricular activities and letters of recommendation.

Submitting Your Portfolio (Work) for Review

The School of Design offers two ways for your work to be reviewed — an on-campus review or a mail-in review. Choose one or the other, but not both.

There are on-campus portfolio reviews during the months of November, January and February. Once you have submitted your application, you must register for a portfolio review online to be

reviewed by the School of Design. Please visit <www.cmu.edu/admission/finearts> for dates and availability. We honor review appointments on a first-come, first-serve basis. Please register as soon as possible to secure a review appointment.

Our design faculty is an integral part of the admission process in determining incoming classes. The faculty gain a deeper understanding of portfolio work and the applicant from an interview with a design faculty member. We strongly emphasize the importance of an on-campus review.

On-Campus Portfolio Options

The School of Design provides three options for presenting your work on campus. With each option a faculty committee will independently review your portfolio and a faculty member will conduct a brief interview with you. The options are:

- **Traditional Portfolio:** An organized presentation of original work. Work may include: sketchbooks, drawings, 2-D and 3-D work, examples of color work and supplemental work. If the scale of your work is too large to transport, then a good quality photo is permissible. This on-campus option typically provides faculty the greatest insight to the quality of your work, your thinking and developmental process.
- **Digital Portfolios and Work:** We will review work presented in digital formats. This work should not be a duplication of work already presented (i.e. accompanying slides, prints, or actual work). To have this work reviewed you must bring a laptop computer with the work already prepared for showing. Otherwise it cannot be reviewed. Also keep in mind that a presentation of final work alone is not helpful in understanding your thinking and development processes. Inclusion of process work/sketches is important.
- **Design Project:** offered as an option for applicants who have a limited portfolio or none at all.

Mail-in Portfolio Options

The School of Design provides two options for presenting your work through the mail. With each option a faculty committee will review your portfolio and a faculty member may conduct a phone interview with you. In the case of a phone interview, you will be notified in advance of the call. The options are:

- **Slide portfolio:** An organized presentation of work. Sample sketches, drawings, 2-D and 3-D work, examples of color work and supplemental work are helpful to include. In addition, a slide key containing a short description of corresponding pieces must be included. Slides should be shot with proper lighting so as to depict subtle details in your work.
- **Digital portfolios and work:** We will review work presented in digital formats. The work must be submitted in CD or DVD format. This work should not be a duplication of work already presented (i.e. accompanying slides or prints of work). Also keep in mind that a presentation of final work alone is not helpful in understanding your design process.

Mail your portfolio to the address below no later than January 15 (November 1 for Early Decision applicants):

Office of Admission -- Design Portfolio
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213-3890

General Portfolio Guidelines

1. Actual work, rather than photographs of work, is preferred for on-campus reviews.
2. Attempt to limit your portfolio through careful editing to 15-20 items (a sketchbook counts as one item).
3. Projects should be as varied as possible, while emphasizing the strongest work. Acceptable work includes, but is not limited to, 2-D and 3-D design, drawing, painting, sculpture, digital and inventions. Design faculty encourages all applicants to include examples of drawing. Drawings can be from life or from the imagination, but they should not be copied from a photo or other two-dimensional image. Matting and mounting of works is not necessary. Applying fixative to works that smudge is highly recommended.

Mail-in Portfolio Guidelines

1. If submitting slides the format is 35mm. Slides should be numbered and sequenced in a standard 9"x12" clear plastic page.
2. A slide key containing a short description of corresponding items must be included. Slides should be shot with proper lighting so as to depict the details in your work.
3. If submitting digital media, the format is CD or DVD. Test your data to ensure its ability to be opened and reviewed.
4. Do not mail original work (drawings, paintings, 3D, etc.) or sketchbooks.
5. Place your name on all materials.
6. Include a self-addressed and postage-paid envelope to return your materials.

Design Project

If you have limited work in your portfolio, the Design Project is an option to supplement that work. If you have no portfolio or work, the Design Project will serve to satisfy the portfolio requirement. Download the project from the Design Web site, www.design.cmu.edu. There you will click on "Admission", "Undergraduate" and "Portfolio" and scroll down to the "Design Project" Link.

Complete the project and bring it with you to your scheduled on-campus faculty interview. Or, if you choose the mail-in option, return it by mail along with your slides or digital portfolio.

Please visit the School of Design's Web site www.design.cmu.edu for specific program information and the most current updates.

National Portfolio Days

Carnegie Mellon participates in National Portfolio Days throughout the United States. Design faculty attending selected National Portfolio Days will provide informal portfolio critiques for those considering application. Please see www.cmu.edu/admission/finearts for dates and locations. A National Portfolio Day critique does not satisfy the formal portfolio review process required for admission.

Transfer Into Design

Whether you are transferring from another university or from one of Carnegie Mellon's other colleges, you'll be classified as a freshman in the School of Design unless you have completed a program equivalent to our freshman year. If you would like to be considered for advanced standing, indicate the level of entry on your Common Application Supplement in the space provided. You must also interview with a member of the design faculty and submit a portfolio to qualify for advanced standing consideration; we will determine your standing through the portfolio review, the interview and your transferable program credits. You should plan to come to campus on the portfolio review date especially scheduled for transfer applicants.

If you plan to enter at the freshman level and do not seek consideration for advanced standing, follow the procedures for application as a freshman. Only fall semester transfer applicants are considered.

School of Drama Admission Procedure

The School of Drama at Carnegie Mellon is a member of the Consortium of Conservatory Theatre Training Programs. To apply to the School of Drama:

- You must schedule an audition or portfolio review online in order to be considered for admission to the School of Drama (with the exception of Dramaturgy applicants); please go to www.cmu.edu/admission/finearts for dates and availability. All audition or portfolio review registrations are made online; at that time, you will be prompted to pay your \$80 audition fee. If you are unable to pay by credit card, call the Office of Admission at 412-268-2082 for further instruction. We honor audition or portfolio review appointments on a first-come, first-served basis. Please register as soon as possible to secure an appointment. When making your registration, please be sure to use an email address that will be active and accessible throughout the application and audition process as this will be the School of Drama's primary means of communication.
- Submit the Common Application and the Carnegie Mellon Common Application Supplement to the Office of Admission by January 1, 2009. Indicate on the Supplement which particular

drama option you wish to pursue. Please note that there is no Early Decision consideration available for the School of Drama, although you may audition in November if you submit your application by November 1, 2008.

- You will receive an email confirmation of the time and date of your audition/review shortly after registering. If you do not pay the \$80 fee online, you will have 48 hours to finalize payment via alternative means as discussed with the Office of Admission (see above); after two weeks with no payment of the audition fee, your audition registration will be cancelled.
- Allow at least four hours for your audition and one hour for your portfolio review
- Transfers follow same procedures as freshman applicants
- Transfer students in Acting and Music Theatre will be classified as freshmen within the program
- There are no Acting or Music Theatre auditions by mail.
- International Drama Design applicants may submit a portfolio by mail. Domestic students must interview in person, except under extreme circumstances, at the discretion of the Option Coordinator. Please contact the School of Drama to make arrangements.

Acting Option

If you're applying to the Acting Option, you must fulfill an audition requirement, which is the main basis for admission. Bring a resume and headshot with you on the day of your audition, and please arrive approximately a half-hour before the audition time, as there are administrative requirements to take care of before the audition begins. Please pay close attention to these audition guidelines:

- You'll be required to perform two contrasting monologues, each approximately two minutes in length.
- The monologues are to be contrasting: one classical monologue from a play written before 1900 with an emphasis on language; and one contemporary monologue from a piece written in the 20th or 21st Century.
- Both pieces should be age and gender appropriate.
- Be sure you've read the entire play, so you can demonstrate an understanding of the character and situation involved.
- You should not have been coached, as coaching often obscures natural ability and instinct. We do not recommend it.
- You may use hand props, but not costumes.
- Be prepared to perform a third monologue if asked.
- Some contemporary pieces have become overused; we ask you not to choose monologues from the following plays: *Slow Dance on the Killing Ground*, *I Hate Hamlet*, *Star Spangled Girl*, *Runaways*, *Nuts*, *A My Name is Alice*, *Identity Crisis* and *Quilters*.

Directing Option

Applying to the Directing Option includes two distinctive parts—an audition, and an interview—which take place in one half-hour appointment. For the audition, follow the audition guidelines for the Acting Option audition, with one major change—plan to perform only one monologue. For the interview, please bring with you a statement describing why you are pursuing this line of study, explaining your choice of monologue and including a critical analysis of the play. Please also bring with you any director's scripts, design portfolio, dramatic writing, photography or any other evidence of your creativity. The interview will also cover aspects of your drive, maturity, vision and aptitude for Directing.

Drama Design Option

If you're applying to the Drama Design Option, you must demonstrate basic proficiency in drawing, painting and design via a portfolio review. The portfolio should include about 15 items of work in several art media and techniques. Not all samples of your work have to pertain to the theatre. We'd like to see examples of:

- Use of color
- Line drawing
- Drafting

The portfolio review will also include a short interview, where we will get a sense of your drive, aptitude for design and fit for this rigorous program. Also, please arrange for two letters of recommendation to be sent by people capable of describing your work and evaluating your professional promise.*

Dramaturgy Option

The Dramaturgy Program provides a rigorous academic and artistic training sequence, emphasizing criticism, history and practical skills, most importantly writing. Applicants must prove that they have the necessary research and writing skills to succeed in this environment. Dramaturgy applicants do not need to schedule an audition or portfolio review; instead, please include the following with your admission application:

- A resume or Curriculum Vitae
- A letter describing your theatre experience and ambitions in the theatre
- Two letters from recommenders familiar with your research and writing skills
- A sample of original research writing of 1,000 words or longer (APA or MLA citation please)

There is no in-person interview required, but the Option Coordinator may contact applicants via phone or email to obtain further information needed.

Transfers in Dramaturgy

The admission process is identical for transfer students and incoming freshmen. Whether you are transferring from another university or from one of Carnegie Mellon's other colleges, you will be classified as a freshman in the Dramaturgy Option, unless you can demonstrate you have completed a program equivalent to the Dramaturgy Option's freshman year. Any courses you may have taken elsewhere that are part of the Dramaturgy requirements, but are non-Drama courses (e.g. English literature, history, foreign languages, etc.) will be counted towards your Dramaturgy graduation requirements.

Students admitted to the School of Drama in another option, who wish to join the Dramaturgy Option, do not need to reapply, but they would need the written approval of the Dramaturgy Option Coordinator. Candidates are evaluated on a variety of criteria, including research and writing skills, prior academic performance, dedication to the art of dramaturgy and aptitude for dramaturgical work. School of Drama internal transfer students will have their class standing re-evaluated based on the percentage of core requirements completed.

Music Theatre Option

If you are applying to the Music Theatre Option, you must fulfill the audition requirement, which is the main basis for admission. During your audition you will:

- Perform two contrasting songs — one ballad and one "up tempo" song. The cuts should be 32 bars. We have an accompanist with us at all of our audition locations; please bring your sheet music in a binder.
- Learn and perform two dance combinations — one ballet and one jazz — taught by a faculty member (bring appropriate dance attire; you will be given ample time to change).
- Perform two contrasting monologues — see "Acting Option" section for guidelines.

Production Technology & Management Option

If you're applying to the Production Technology and Management Option, you should already have practical experience in the theatre, as well as some background in mathematics and physics, organization and management, or both. You must demonstrate basic proficiency in project planning and execution by submitting a portfolio of your work. The portfolio should include up to 15 examples of work. Not all samples of your work have to pertain directly to the theatre. We'd like to see examples of:

- Evidence of your thought process for technical or management solutions
- Drafting, drawing or CAD
- Paperwork you've used/developed for schedules, reports, budgets, estimates, etc.
- Photos of work both finished and in process

The portfolio review will also include a short interview, where we will get a sense of your drive, aptitude for production technology and management, and fit for this rigorous program. Also, please arrange for two letters of recommendation to be sent by people capable of describing your work and evaluating your professional promise.*

*Ask those who write letters of recommendation for you to send them, by January 1, 2009, directly to:

Office of Admission – Drama Design/PTM
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213-3890
Fax 412-268-7838

School Of Music Admission Procedure

To apply to the School of Music, complete the following steps by December 1:

- Complete and submit the Common Application and Carnegie Mellon Supplement, in addition to all required supporting materials, to the Office of Admission.
- Indicate your curriculum preference on the Carnegie Mellon Supplement: Instrumental, Voice or Composition.
- Proceed to the School of Music Web site at <<http://music.web.cmu.edu>>, click on the "apply/audition now" link on the home page, and enter the requested information. Be certain to use an email address that will be accessible and active throughout the application and audition process, as this will be the School of Music's primary means of communication.
- Once the requested information is submitted, you will be prompted to pay your \$50.00 audition fee using Visa or Mastercard. If you are unable to pay by credit card, call the Music Admissions Office at 412-268-4118 for further instructions.
- After submitting the audition fee, you will be prompted to make an audition reservation. Follow the posted steps to reserve a date, time and location for your audition. All applicants, including those to flute, voice, piano and composition studios that require a two-phased audition process, should make an audition reservation.
- Expect a confirmation email one week before the scheduled date of your audition.
- Applicants to the voice, flute, piano and composition studios must undergo a two-phased audition process. Please check the audition requirements for these studios carefully. There is no Early Decision consideration for voice, flute, piano or composition applicants.

Auditions

All applicants to the School of Music are required to undergo an audition, and all auditions, even those by recording, must be scheduled through the audition Web site. Applicants may meet the audition requirement through one of three means:

1. Audition in person and on-campus before the specific studio faculty on the Carnegie Mellon campus.
2. Audition in person before a non-performance area faculty member of the School of Music at one of the regional locations. Regional auditions are recorded, and the recordings are reviewed and adjudicated by the studio faculty. The regional audition option is not open to applicants of the percussion, double bass, composition and flute studios.
3. Audition by recording:
 - a. High quality DVD or CD recordings are the only acceptable medium.
 - b. Pieces must be separated by tracks.
 - c. Recording and case must be marked with the applicant's name, the instrument or performance area, the repertoire and the words "audition recording".
 - d. Applicants must meet the specific performance area audition requirements.
 - e. Recordings need to be received at the following address by January 1, 2009:

Carnegie Mellon School of Music
Music Recruitment and Enrollment, CFA 108
5000 Forbes Avenue
Pittsburgh, PA 15213-3890
 - f. Recordings should be sent directly to the School of Music. Recordings should not be sent alone or with other materials to the Office of Admission.

Auditions are held in Pittsburgh and in regional locations between January 19 and February 24. Available dates, times and locations for auditions are listed on the School of Music Web site. Candidates

have the freedom to choose the most convenient location, date and time to hold their audition.

The School of Music is sensitive to the need for advanced travel arrangements for most applicants. Even so, audition appointments are subject to minor change until two weeks before the designated date. Applicants will be notified in advance if such a change is necessitated, and the School of Music will make every effort to collaborate on a feasible alternative date and time to cause minimal disruption. Final audition confirmations will be forwarded to the applicant via email one week before the scheduled audition date.

Flute, voice, piano and composition applicants must complete two auditions. The first is a recorded audition and the second is a live audition. Live audition reservations will only be confirmed and honored for those candidates who perform favorably after the first audition phase.

The audition process requires approximately four hours, as applicants are afforded adequate warm-up time prior to their audition, and will participate in various music placement tests on the audition date.

Applicants are notified of the result of the audition in writing by February 28, 2009. If the audition result is favorable, the Music School will recommend acceptance to the Office of Admission, and the Office of Admission will determine if the student's academic records meet the standards of Carnegie Mellon. If the audition result is not favorable, the applicant will not be admitted to the School of Music, but could be admitted to Carnegie Mellon through an existing application to another school of study.

Audition Requirements

Bagpipes: All applicants to the bagpipe studio are expected to prepare and perform two to three solo compositions of the applicant's choice in order to demonstrate the musical and technical level of achievement on this particular instrument.

Bassoon: All applicants to the bassoon studio are expected to prepare and meet the following performance requirements for auditions:

1. Scales: any major or minor scales as requested
2. A technical etude
3. A solo composition of the applicant's choice that will demonstrate the musical and technical level of achievement on the particular instrument
4. Two or three orchestral excerpts of the player's choice

Cello: All applicants to the cello studio are expected to prepare and meet the following performance requirements for auditions:

1. Scales: any major or minor scale in three octaves as requested
2. One etude by Duport, Popper, or Piatti
3. A movement of a concerto by Haydn or Boccherini or a representative work of the Romantic or Contemporary period

Clarinet: All applicants to the clarinet studio are expected to prepare and meet the following performance requirements for auditions:

1. Scales: any major or minor scales as requested
2. A technical etude
3. A solo composition of the applicant's choice that will demonstrate the musical and technical level of achievement on the particular instrument
4. Two or three orchestral excerpts of the player's choice

Composition: The composition audition is a two-phased process, the first of which involves faculty review of each applicant's original work. By December 1, all composition applicants are required to submit:

1. Three manuscripts of original compositions showing a range of genres
2. A CD recording of a live performance of each of these pieces. If a live performance is not possible, an electronically generated CD will be acceptable.

Materials should be forwarded to:
Carnegie Mellon School of Music
Recruitment and Enrollment, CFA 108
5000 Forbes Avenue
Pittsburgh, PA 15213- 3890

**Recordings and manuscripts will not be returned.*

The composition studio faculty will review and evaluate the original works for each applicant throughout the month of December. Results of the review will be forwarded in writing by the end of December. If the results of this first audition are favorable, the candidate's live

audition reservation will be confirmed. The live composition audition consists of an interview between the applicant and the composition faculty. During the interview, applicants should be prepared to discuss personal compositional processes, background and future goals. It will not be necessary for applicants to perform excerpts, either vocally or instrumentally, of their works during the audition/interview. Copies of manuscripts and recordings may be brought to the interview, but are not required. Although arrangements of works by other composers are welcome, they will be considered supplementary to the basic requirement for three original works.
*Note that composition auditions are held in the Pittsburgh venue only.

Double Bass: All applicants to the double bass studio are expected to prepare and meet the following performance requirements for auditions:-

1. Contrasting movements from any Baroque sonata or suite
2. The first movement of a Classical, Romantic or 20th century Concerto performed from memory
3. Two octave major and minor scales and arpeggios from memory
4. Two orchestral excerpts of your choice

*Note that double bass auditions are held in the Pittsburgh venue only.

Euphonium: All applicants to the euphonium studio are expected to prepare and meet the following performance requirements for auditions:

1. Scales: any major or minor scales as requested
2. A technical etude
3. A solo composition of the applicant's choice that will demonstrate the musical and technical level of achievement on the particular instrument
4. Two or three band or orchestral excerpts of the player's choice

Flute: The flute audition consists of two parts, the first of which involves review of a CD recording which meets the following requirements:

Preliminary CD Guidelines

1. This CD recording must be entirely without piano accompaniment.
2. Recording must be high-quality audio CD. DAT, mini-disc or cassette will not be accepted.
3. Please make sure that your CD is labeled with your name, degree program and a track listing of selected repertoire.
4. Required Repertoire:
 - a. Mozart: Concerto in G or D major – 1st and 2nd movements (exposition only)
 - b. Orchestral Excerpts:
 - Beethoven *Lenore Overture No. 3*—measures 328-360
 - Brahms *Symphony No. 4*, movement IV—measures 93-105
 - Mendelssohn *A Midsummer Nights Dream*, Scherzo—2 measures before P to the end
 - Debussy *Prelude a l'après-midi d'un faune*—rehearsal no. 2-3

All of the above excerpts can be found in *Orchestral Excerpts for Flute* (Baxtresser/ Rearick), published by Theodore Presser.

The CD recording must be **received** at the following address by December 1, 2008. The preliminary audition CD will not be returned. Send the recording directly to the School of Music. Do not mail the audition recording to the Office of Admission:

School of Music, CFA 108
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213- 3890

The flute faculty will convene during the first week of December to review the CDs. Results of the review will be forwarded in writing by the end of December. If the results of this first audition are favorable, the candidate's live audition reservation will be confirmed.

Live audition requirements: Candidates who proceed to the live audition phase will be expected to prepare and meet the following performance requirements:

1. Mozart Concerto – complete
2. Work of the Twentieth Century
3. Four orchestral excerpts of contrasting styles
4. Major and minor scales

*Note that flute auditions are held in the Pittsburgh venue only.

Guitar: Entering freshman guitarists should be familiar with basic right hand techniques and should be able to read music on the guitar up to seventh position. All applicants to the guitar studio are expected to prepare and meet the following performance requirements for auditions:

1. Scales: any major or minor scale as requested
2. Chords: any major, minor or dominant seventh chord as requested
3. Prepare one work from each of the following periods:
 - a. Renaissance or Baroque (e.g. Dowland, Milan, Bach)
 - b. Classical or Romantic (e.g. Sor, Giuliani, Tarrega)
 - c. 20th century (e.g. Villa Lobos, Brouwer, Dyens)

Harp: All applicants to the harp studio are expected to prepare and meet the following performance requirements for auditions:

4. Etude No. 1, from *Cinquante Etudes*, Op. 34, Book 1, by Bochsa
1. Two contrasting works: one Classical and one by a 20th Century composer, such as an etude from *Bach-Grandjany Etudes for Harp and Natra Sonatine*
2. Two orchestral excerpts, including the harp cadenza from *Waltz of the Flowers* by Tchaikovsky

Horn: All applicants to the horn studio are expected to prepare and be ready to perform, upon request, the following items:

1. Mozart, Concerto # 2: 1st movement, exposition and development
2. Strauss, Concerto # 1: 1st & 2nd movements
3. Bach, Cello Suite # 1, Sarabande: In original cello key, not the Wendell Hoss edition
4. Reynolds, 48 Etudes for French Horn: # 39 or # 41
5. Brahms #1: 1st horn, 4th movement intro calls
6. Mahler #1: 4th horn low tutti, 3rd movement
7. Strauss, Till Eulenspiegel: 1st horn both intro calls
8. Tchaikovsky # 5: 1st horn 2nd movement solo
9. Wagner: Short Call
10. All major and minor scales

Oboe: All applicants to the oboe studio are expected to prepare and meet the following performance requirements for auditions:

1. Scales: any major or minor scales as requested
2. A technical etude
3. A solo composition of the applicant's choice that will demonstrate the musical and technical level of achievement on the particular instrument
4. Two or three orchestral excerpts of the players choice

Organ: The organ audition consists of three parts:

1. One of the *Eight Little Preludes and Fugues* by Bach
2. A movement of an organ sonata by Mendelssohn, Guilmant or the equivalent
3. Sight reading of a hymn from a hymn book

Percussion: Those auditioning for the percussion department are expected to demonstrate superior ability in one of the six categories listed below. All students are required to play from categories I, II, and V for admission into the Percussion Department. Competency in one additional category must be demonstrated. Auditions in all categories are not required. Applicants will be evaluated on the basis of techniques, a prepared piece, sight-reading and ear test. Memorization of a piece is optional. Sticks and mallets are to be brought by the individual auditioning. Instruments will be provided by the percussion department. A copy of the prepared pieces must be provided for the jury. Percussion auditions are conducted only in the Pittsburgh venue.

Specific audition requirement in the various categories:

- I. Timpani: Demonstrate the various types of rolls (fp, p, f, ff, etc.), rhythms and interval tuning: solos and/or etudes (Hochrainer, Delecluse, Goodman, etc.); orchestral excerpts (Beethoven, Brahms, Mozart, Hindemith, etc.).
- II. Keyboard Percussion: Perform two octave scales and arpeggios in major and minor keys, four-mallet solo (marimba), two-mallet solo (xylophone or marimba); orchestral excerpts (bells, xylophone or vibraphone).
- III. Drum Set: Demonstrate various styles: Swing, Bop, Rock, Latin, Runk. Play short solo incorporating all of the styles.
- IV. Latin Percussion: Techniques on bongos, congas, timbales, claves, maracas, etc.
- V. Snaredrum: Play various types of rolls from slow to fast (5-stroke, 7-stroke, etc.) Demonstrate other rudiments upon request. Solo (concert and rudimental style); ex:

Pratt, Wilcoxin, Cirone, Peters, Delecluse, etc.). Orchestral excerpts.

VI. VI. General Percussion: Demonstrate techniques on crash cymbals, tambourine, triangle, castanets, bassdrum, etc.

Piano: The piano audition consists of two parts, the first of which involves review of a recording that meets the following requirements.

Audition Recording Guidelines

1. Recording must be high-quality audio CD. DAT, mini-disc, cassette or video recordings will not be accepted.
2. Pieces must be separated by tracks.
3. The length of the recording must be at least 20 minutes.
4. The CD and the CD case must be labeled with your name, your degree program, the words "Piano Audition" and a track listing of selected repertoire.
5. Required Repertoire:
 - A Baroque or Classical work (17th century Beethoven)
 - A Romantic, 20th Century or Contemporary work demonstrating the applicant's pianistic and artistic ability

The CD recording must be received at the following address by December 1, 2008. The audition CD will not be returned. Send the recording directly to the School of Music. Do not mail the audition recording to the Office of Admission.

School of Music, CFA 108
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213-3890

The piano faculty will convene during the first week of December to review the CDs. Results of the review will be forwarded in writing by the end of December. If the results of this first audition are favorable, the candidate's live audition reservation will be confirmed. Candidates who do not receive a favorable response from the first, recorded audition, and candidates who do not submit a first audition recording will not be considered for admission to the School of Music.

Live Audition Requirements

Candidates who proceed to the live audition phase will be expected to prepare the following works:

1. A polyphonic work (late-Renaissance to contemporary)
2. One or more movements of a Classical Sonata (J.C. Bach, Haydn, Mozart, Clementi, Beethoven or Schubert)
3. A substantial Romantic, 20th-century or contemporary composition demonstrating the applicant's pianistic and artistic ability

Candidates have the option of performing the same pieces for both auditions, though this is not a requirement. More importantly, the pieces that the candidate lists on the School of Music online application are the pieces that should be performed at the live audition.

Saxophone: All applicants to the saxophone studio are expected to prepare and meet the following performance requirements for auditions:

1. Scales: any major or minor scales as requested
2. A technical etude
3. A solo composition of the applicant's choice that will demonstrate the musical and technical level of achievement on the particular instrument
4. Two or three orchestral excerpts of the player's choice
5. A jazz selection of the applicant's choice that will demonstrate style and articulation. Improvisation suggested, but not required.

Trombone: All applicants to the trombone studio are expected to prepare and meet the following performance requirements for auditions:

1. Scales: any major or minor scales as requested
2. A technical etude
3. A solo composition of the applicant's choice that will demonstrate the musical and technical level of achievement on the particular instrument
4. Two or three orchestral excerpts of the player's choice

Trumpet: All applicants to the trumpet studio are expected to prepare and meet the following performance requirements for auditions:

1. Two contrasting etudes (one lyric, one technical) from etude books such as:
 - a. Charlier
 - b. Etudes Transcendantes
 - c. Arban, Characteristic Studies
 - d. H. L. Clarke, Characteristic Studies
2. A solo of your choice such as:
 - a. Kennan, Sonata for Trumpet and Piano
 - b. Hindemith, Sonata for Trumpet and Piano
 - c. Haydn, Concerto in E flat for Trumpet
3. Two or three orchestral excerpts of your choice such as:
 - a. Beethoven, Leonore 2 or 3
 - b. Mussorgsky/Ravel, Pictures at an Exhibition—Promenade
 - c. Respighi, Pines of Rome—offstage solo

Tuba: All applicants to the tuba studio are expected to prepare and meet the following performance requirements for auditions:

1. Scales: any major or minor scales as requested
2. Selections of contrasting styles, including:
3. An etude
4. A solo composition of the applicant's choice that demonstrates his or her musical and technical level of achievement
5. Two or three orchestral excerpts of the player's choice

Viola: All applicants to the viola studio are expected to prepare and meet the following performance requirements for auditions:

1. Major and minor scales and arpeggios in three octaves with various bowings
2. One etude by Campagnoli, Lillian Fuchs, Rode, Palaschko, Dont, etc.
3. Two contrasting movements from any Bach solo suite (originally for cello) or sonata or partita (originally for violin)
4. A sonata movement or short work
5. A representative substantial portion of a concerto Examples include (but are not limited to):
 - a. A slow-fast pair of movements of the Telemann
 - b. First movement with cadenza of the Stamitz D Major, Hoffmeister D Major, Rolla E-flat Major or Vanhal C Major
 - c. First or second movement of Walton
 - d. First or second and third movements of Bartok
 - e. Any movement of Hindemith Der Schwanendreher
 - f. A substantial fast movement of any 20th or 21st-century concerto

A high quality DVD is the only acceptable medium for those auditioning by recording for the viola studio.

Violin: All applicants to the violin studio are expected to prepare and meet the following performance requirements for auditions:

1. Scales: one major and one minor scale and arpeggios in three octaves, as requested
2. One etude by Kreutzer, Fiorillo, Rode, Dont or Gavinies or a caprice by Wieniawski or Paganini (played by memory)
3. An allegro movement of a non-Baroque concerto (played by memory)
4. One movement of a Bach solo sonata or partita (played by memory)

A high quality DVD is the only acceptable medium for those auditioning by recording for the violin studio.

Voice: Candidates are expected to have a voice with professional potential and some experience in solo singing. Note that the Voice Performance program in the School of Music is separate from the Musical Theatre program in the School of Drama, and application to one program does not provide consideration in the other.

The vocal performance audition is a two-phased process, the first of which involves review of a CD recording which meets the following requirements:

1. Three selections, separated by tracks, on a CD recording. No other recorded media type will be accepted.
2. All selections must be in the Classical style. Musical Theatre selections will not be accepted.
3. The first selection must be performed in English.
4. The second selection must be performed in Italian.
5. The third selection may be performed in any language of choice.
6. CD and CD case must be labeled with your name, your degree program, your voice and a track listing of your

selected repertoire.

7. CD recordings must be received in the Music Office by December 1.
8. CD's should not be sent to the Office of Admission. To prevent your recording from being misdirected, please forward directly to the School of Music at the exact address listed below:

Carnegie Mellon School of Music
Recruitment and Enrollment, CFA 108
5000 Forbes Avenue
Pittsburgh, PA 15213- 3890

The voice faculty will convene during the first week of December to review the CDs. Results of the review will be forwarded in writing by the end of December. If the results of this first audition are favorable, the candidate's live audition reservation will be confirmed.

Applicants who do not achieve a favorable result following the first audition, and applicants who do not submit an audition recording by December 1 will not be considered for a live audition.

Candidates who proceed to the live audition will be expected to perform the three selections indicated on the recording. Some sight-singing may be required as well. Those who will require the services of a School of Music accompanist must forward copies of the music to the above address by January 1. Music must be double-sided, non-stapled, separated by paperclip, labeled with the applicant's name, in the desired key, and with clearly designated marks for cuts, etc. An accompanist is provided in the Pittsburgh audition venue.

Exploring Carnegie Mellon

Visiting a campus is one of the best ways for you to discover which school is right for you. At Carnegie Mellon, we strongly recommend that you attend an information session or interview with a counselor from the Office of Admission while on campus. Our interviews are viewed as an information exchange—we want to get to know you, just as you may want to learn more about us! During the interview, you'll have the opportunity to ask questions about admission requirements, financial aid, student life, Pittsburgh—and much more!

If you'd like an interview, request an appointment at least three weeks prior to the date you're coming to campus. Interviews are available Monday through Friday throughout the summer and until mid-November. However, because we spend a great deal of time reviewing applications between January 1 and May 1, we do not conduct interviews during this time period. To schedule an information session or an interview, call 412-268-2082 on any weekday between 8:30 a.m. to 5 p.m. (EST).

On-campus auditions and portfolio reviews usually include an interview with a member of the Fine Arts faculty and a campus tour. Therefore, only one campus visit is necessary. Students should plan to spend about four hours on campus during these events.

Campus Tours

Campus tours are conducted by student admission assistants and leave from the Office of Admission, 101 Warner Hall. On weekdays during the academic year, we conduct four tours daily at 9:30 a.m., 11:30 a.m., 1:30 p.m., and 3:30 p.m., as well as a residence hall tour at 1:00 p.m. Saturday tours and group sessions are held during the fall. Tours may not be available during university holidays, vacations or final exam periods in mid-December, late March, mid-April and early May. To be sure a tour is available on the day you're coming to the campus, please call 412-268-2082.

Hometown Interviews

Although we strongly recommend a campus visit, we realize that it is not always possible for you to come to campus. The Admission staff does travel to various parts of the country interviewing students in their hometowns. Information about making an appointment will be mailed to students prior to the time we arrive in your city. Students who interview on campus do not have to schedule another interview in their hometown. The specific dates and locations for Hometown Interviews are listed online at www.cmu.edu/admission.

Alumni Interviews

We encourage students to talk with a member of the Carnegie Mellon Admission Council (CMAC). CMAC, a select group of alumni, helps the Admission staff reach out to prospective students. Alumni interviews are as valuable when making admission decisions as interviews with the Admission staff. If you're interested in interviewing with a member of CMAC, please call the Office of Admission.

Sleeping Bag Weekends

The more information you have, the better decisions about college you'll make! The Admission staff invites you to learn more about Carnegie Mellon by living like a university student for a day and a half in our Sleeping Bag Weekend program. Visits begin on Sunday afternoon and last through Monday afternoon.

Sleeping Bag Weekends give you the opportunity to learn everything you may want to know about Carnegie Mellon. The weekend activities allow you to:

- meet current students, faculty members, deans and admission counselors
- attend information sessions about the university and specific programs
- stay overnight in a residence hall
- tour the campus
- attend classes
- eat at the dining facilities

There are four Sleeping Bag Weekends in the fall and winter. If you are on our mailing list, you should receive an invitation in the early fall. To reserve a place at a Sleeping Bag Weekend call us at 412-268-2082 or visit www.cmu.edu/admission/sbw.

Information Sessions

Each fall, the Admission staff travels across the country, meeting with groups of students and parents. We discuss the college selection process, admission requirements and financial aid. Prior to the event, you should receive an invitation stating the time and location of the program. Reservations are preferred, and we encourage students and parents to attend.

Call Carnegie Mellon for Assistance

If a student will need assistance while visiting the campus, due to a physical or learning disability, he/she should call us at 412-268-2082, and we will help meet the student's needs during his/her visit at Carnegie Mellon.

Directions to Campus

Carnegie Mellon's campus is:

- located approximately five miles east of downtown Pittsburgh in the Oakland neighborhood
- accessible by ground, rail, or air transportation

To listen to a recorded message of directions to campus, please call (412) 268-8343.

Driving from the east:

- Take the Pennsylvania Turnpike West to Exit 57, Pittsburgh/Monroeville.
- Follow Interstate 376 West to Exit 7, Edgewood/Swissvale.
- Turn right onto Braddock Avenue (at the end of the ramp).
- Continue to the Forbes Avenue intersection (Frick Park will be on the left).
- Turn left onto Forbes Avenue and follow it approximately three miles to campus.
- At the intersection of Forbes Avenue and Beeler Street, you will find the parking garage on your left. If this side entrance is closed, continue on Forbes Avenue to the main entrance.

Driving from the west/north:

- Take the Pennsylvania Turnpike East to Exit 28, Perry Highway.
- Follow Interstate 79 South to 279 South, Exit 72.
- Follow signs and go over the Fort Duquesne Bridge.
- Take 376 East to Exit 2A, Forbes Avenue/Oakland.
- Stay in the right-hand lanes, following Forbes 1.3 miles through the Oakland business district to campus.
- Immediately at the intersection of Forbes Avenue and Beeler Street, turn right into the parking garage on campus.

Driving from the south:

- Take Interstate 79 North to 279 North (Pittsburgh).
- Follow 279 North toward Pittsburgh through the Fort Pitt Tunnel and onto the Fort Pitt Bridge.
- Once on the bridge, stay in the far right lanes and follow signs for 376 East/Monroeville, Exit 6A.
- Take 376 East to Exit 2A, Forbes Avenue/Oakland.
- Stay in the right-hand lanes, following Forbes 1.3 miles through the Oakland business district to campus.
- At the intersection of Forbes Avenue and Morewood Avenue, the garage entrance will be on your right after you go through the light.

**Please note that visitor parking is extremely limited on campus and may not always be available. Please allow extra time to find parking. For maps and parking options, please visit our Web site <http://my.cmu.edu/site/admission/page.travel_accom> for details.*

Summer Opportunities

The campus is in full operation during the summer, populated by students and faculty from a variety of programs. The university continues to have outstanding, innovative educational programs extending beyond regular involvement with its degree candidates. Seven such programs are offered during the summer for high school students: the Pre-College Programs in the Fine Arts (Architecture, Art, Design, Drama and Music), the Advanced Placement Early Action Program and the Summer Academy for Mathematics and Science. Three sessions of summer school are held for college students who wish to make up or advance their degree program studies. Every service and support organization is available to summer students: the Computer Center, the Health Center, the Counseling Center, the libraries, the Office of Admission, the Career Center, Student Activities, etc.

Summer Pre-College Programs for High School Students

Office of Admission, Warner Hall 206

The Pre-College Programs are designed to preview an actual college experience. Our programs afford high school students many opportunities for personal growth and development within a university setting. A wide range of social, cultural, and recreational activities are planned by a staff of resident counselors to fully integrate the students' lives on campus and in Pittsburgh. Movies, dances, museum and gallery visits, field excursions or attendance at professional theater productions, concerts, and Pittsburgh Pirates games are just a few of the sponsored activities.

Summer Academy for Mathematics and Science

Students with diverse backgrounds who are entering their junior or senior year and considering careers in engineering, science and other math-based disciplines are eligible to participate in this rigorous program. Traditional classroom instruction, along with creative "hands-on" projects will allow students to apply concepts and principles.

Advanced Placement Early Action Program

The Advanced Placement Early Admission (APEA) Program is a challenging summer program intended for high school students who want to enrich their educational experience by taking college classes identical to those that a Carnegie Mellon freshman would take. The program is designed for mature, motivated students who seek to gain advanced placement credit and who are eager to sample college life early by living in a residence hall and participating in educational, social, and recreational activities.

The faculty teaches courses in biology, calculus, chemistry, engineering, computer science, philosophy, business, economics, modern mathematics, physics, history and writing during the six week program, and additional classes are added each year. Resident students are required to take two courses during the summer program. The two-course load is slightly less demanding than the typical five-course load during the regular semester; however, it remains close enough for a student to measure his ability to meet the pressure of college life.

All APEA classes meet daily. Class sizes are kept small, giving students a personal environment in which to learn. Although a substantial amount of homework is inherent in the program, it will naturally vary from course to course and from student to student. The program makes available tutorials in the more technical subjects.

Students who do exceptionally well in the APEA Program and who meet current admission standards are sometimes invited to apply for early admission to Carnegie Mellon if space is available. Carnegie Mellon is always interested in academically talented high school juniors who have the academic ability to skip their senior year entirely and accept early admission to college. This is especially true for capable students whose academic and career goals are

clear. Students must take two courses in order to be considered for early admission to Carnegie Mellon. Depending on their academic interests, credentials, and space available, these students may enroll in the Carnegie Institute of Technology (engineering), Mellon College of Science, School of Computer Science, Tepper School of Business, or the College of Humanities and Social Sciences. Students who are accepted have the option of omitting their senior year and coming to campus in the fall as full-time students. It should be emphasized that space can be especially tight in engineering, and in particular Electrical and Computer Engineering and Computer Science. Participation in the APEA program does not guarantee early admission or even regular admission to Carnegie Mellon.

Whether students are admitted early or not, the credit earned in the APEA Program and the experience gained can be an advantage. For students who eventually enter Carnegie Mellon, the six credits form a head start, but these credits are also accepted as advanced placement credit at other universities. In order not to prejudice any application for admission in the future, no record of marginal or failing work is kept, much less released. In this regard, APEA is risk free.

Applications are also encouraged from very adventuresome young students who are years away from college (ninth graders, for example) and reside in the Pittsburgh area. Aside from its strong academic orientation, the APEA Program affords both residents and commuters many other opportunities for personal growth and development within a university setting.

Tutorials are available as a part of the program. However, students should be aware that the calculus course assumes a knowledge of algebra, trigonometry, and geometry; that the physics course assumes a high school physics course has been taken, and recommends concurrent registration in calculus; and that the chemistry and biology courses assume a high school course in chemistry and/or biology has been taken.

The hard work, the independence, the pleasure of accomplishment, the interaction, the cultural and intellectual setting and, in a good way, the pressures of academic life, are combined in the APEA program to closely approximate the full rewards of a college experience.

Pre-College Architecture Program

The Pre-College Architecture Program is an opportunity for those high school students who have completed their junior year to discover whether they have the necessary aptitudes for further study at the college level. The students learn the nature of professional training, discover if they enjoy this type of concentration and most importantly, realize the degree of their individual talents. At the conclusion of the period of study, each student's work is evaluated indicating the level of aptitude in this field.

The program is divided into three components which occupy the entire day. In the morning, students attend lecture-style courses covering a range of topics, including architectural history, technology, and the architecture profession. Students will attend drawing classes, teaching both hand-drawn and computer drawing techniques. These are introductory courses, assuming no prior experience.

Each afternoon, students meet for design studio. The studio is a hands-on environment, challenging students to design solutions to given spatial problems. This course teaches fundamental design skills, modelmaking and drawing craft, critical thinking, and creative speculation.

Field trips will be to local cultural institutions, construction sites, and to local architecture firms.

At the conclusion of the program, the student will receive a private consultation with faculty, as well as a written letter of evaluation on the student's progress and aptitude.

Pre-College Art Program

The summer Pre-College Art Program gives interested and talented high school students an opportunity to discover whether they have the necessary aptitudes for studying art at the college level.

When we make art, we not only satisfy human need for personal discovery and communication, but we also engage in the privilege to question, to be different, to challenge the status quo as an exercise in self-expression and free speech.

Students will be able to choose three specific art studios to study in three-week modules during the program. The areas include two-dimensional (painting, drawing, computer animation/graphics and printmaking), and three-dimensional (sculpture, installation and materials) and includes art history and concept studio.

A written evaluation of each student's work is made at the conclusion of the six-week session. Students who intend to apply for admission to Carnegie Mellon for freshman admission to the department may schedule an interview with the Office of Admission. Students may request a portfolio review for admission or an informal critique during the last week of the program.

Pre-College Design Program

Design has an important influence on contemporary life. Nearly everything that has been manufactured or printed— packages, appliances, furniture, books, cars, magazines, etc. — has been influenced by a designer sensitive to social, aesthetic, technical and economic principles.

Full-time design faculty provide not only an integrated study program of graphic design, product design, drawing, photography and computer graphics, but also professional career counseling and guidance appropriate to students. A final positive review of individual student work by all faculty can fulfill the portfolio requirement for admission as freshmen to the department.

The six-week program consists of three-hour classes each morning and afternoon and includes homework assignments. During the registration period, all students will receive a list of required materials. Students may either bring materials from home or purchase them at the campus art store. Special activities could include visiting lectures or field trips to professional design studios. A written evaluation of each student's work will be sent to the parents at the completion of the program.

Pre-College Drama Program

Carnegie Mellon's drama program has an innovative and dynamic history that has produced graduates in every branch of theater, film, television and video.

If you're a serious theater student, or debating whether to become one, you can come here with a good deal of experience or almost none at all, as long as you come ready to work hard and learn.

A Carnegie Mellon summer is a rich and exciting experience. The Pre-College program focuses on creative growth and preparation for actors, musical theater students and technical apprentices. Carnegie Mellon Drama faculty members will coach you, evaluate your work and help steer you into compatible studies, whether those studies take place at Carnegie Mellon or elsewhere. Outstanding students have a possibility of fulfilling the talent portion of our admission process through this program.

Pre-College Music Program

Carnegie Mellon's School of Music is a stimulating, vibrant place where talented young performers, composers and conductors prepare for professional careers in music. At Carnegie Mellon, tradition and technology coexist. Building upon 75 years of excellence as a conservatory, turning out superb musicians who are known throughout the world as performers, composers, conductors and teachers, the School has become a leader in the field of computer music. New state-of-the-art computer music facilities challenge the most adventurous young musicians to learn more about acoustics and discover new sounds. Music theory software, developed at Carnegie Mellon, enhances the curriculum, and the finest composition software on the market is available to assist the young composer in creating new music. Expert instruction in sound recording provides yet another opportunity for young musicians interested in broadening their musical base. At Carnegie Mellon students are taught to appreciate, to understand, and to perform the music of the past, yet they are also expected to be comfortable with the innovative sounds of the future.

Becoming a professional musician requires extraordinary talent and versatility. The complete musician must be prepared to play jazz as well as classical and contemporary repertoire. Therefore, at Carnegie Mellon a full program of jazz studies is available to enhance the conservatory training. Singers learn to act, to dance, to perform in several languages. Composers learn to conduct, to prepare orchestral scores, to rehearse their own works. Pianists are expected to sight read, play chamber music, accompany singers, and play synthesizer. Music at Carnegie Mellon is more than practicing an instrument — it is an intense, exciting course of study, experienced side by side with other young musicians who share the same goals and aspirations.

The six-week Summer Music Program offers a unique taste of the life of a student musician at Carnegie Mellon in a low pressure environment of study and performance. This is an ideal opportunity to discover your potential for a career in music. Within the rich cultural life of the city of Pittsburgh and the varied activities on the Carnegie Mellon campus, the Summer Program is an extraordinary way for a young musician to spend the summer.

The Summer Program has four main concentrations: Performance, Composition, Jazz Studies and Music Technology. Each student follows an individual schedule designed to meet specific needs and interests. Private lessons are mandated for every student, and a group of music support courses is common to all four areas. Students are encouraged to explore courses outside their area of concentration to insure comprehensive music training.

Applicants to the Summer Music Program should send a statement describing their past musical training, and a recent audio recording (cd preferred) of two selections, representative of their level of performance, or copies of original compositions, with the application materials.

National High School Game Academy

The National High School Game Academy (NHSGA) is an intensive study of video game design and development. This six week program includes an exciting blend of hands-on exercises combined with traditional lecture and discussion. If you are interested in exploring the world of video game development, the NHSGA may be for you!

Modeled after Carnegie Mellon's graduate program in Entertainment Technology and corporate sponsored by Electronic Arts, the NHSGA is structured to give students a taste of the current state of video game development and guidance towards embarking on their own career in the video game industry.

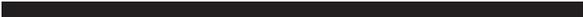
Students are encouraged to expand their creativity in a unique blend of left- and right-brain college-level work. Students will be encouraged to pursue undergraduate studies in software engineering, design, creative writing or dramatic arts after the program after gaining an understanding of how their education can lead to a career in the interactive digital media field.

Requests for applications and further information should be addressed to:

Pre-College Programs
Office of Admission
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213-3890
(412) 268-2082
FAX: (412) 268-7838



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Enrollment Services

Linda Anderson - Director of Enrollment Services and Director of Student Financial Assistance and Services

John Papinchak - Director of Enrollment Services and University Registrar

Warner Hall A-19

5000 Forbes Avenue Pittsburgh, PA 15213-3890

Phone (412) 268-8186

Fax (412) 268-8084

thehub@andrew.cmu.edu

www.cmu.edu/hub

The HUB

The HUB is Enrollment Services' student service center. The Assistant Directors of Enrollment Services are available in The HUB Monday, Wednesday and Friday from 8:30 a.m. until 4:30 p.m., and Tuesday and Thursday from 10:30 a.m. until 4:30 p.m., to assist students with enrollment matters including registration, financial assistance, and student accounts. Parents and students are encouraged to contact the Assistant Directors by visiting The HUB, Warner Hall A-19, or by visiting The HUB website, www.cmu.edu/hub.

Carnegie Mellon Card Office

The staff members of the Carnegie Mellon Card Office are available to assist you with all of your ID+ Card needs. Card Office hours are from 8:30 p.m. to 4:30 p.m., Monday through Friday.

Plaid Ca\$h

Plaid Ca\$h is a debit account with the university. The account is accessible by presenting your Carnegie Mellon ID+ Card to the cashier at any of the locations where Plaid Ca\$h is accepted. For more information, visit The Card Office in Warner Hall, lower level, or The Card Office website at www.cmu.edu/idplus/.

Undergraduate Enrollment

Enrollment is the process whereby eligible students notify Enrollment Services that they will be attending the university by registering for courses and settling their student accounts. Enrollment must be completed before students may begin classes and before they may utilize university facilities.

Complete information about the enrollment process is available on The HUB Website. Registration and payment deadlines are listed on the Official Academic Calendar, located on The HUB Website, <http://www.cmu.edu/hub>.

Registration

Registration is the process of selecting courses for the upcoming semester and discussing those selections with an academic advisor. We strongly encourage you to meet with your academic advisor before you finalize your selections and register for courses using On-Line Registration (OLR). OLR can identify your advisor and facilitate contact with your advisor via e-mail as part of the automatic registration process.

Registration for most entering freshmen is accomplished with the assistance of Associate Deans and department heads during the summer. Academic placement and elective choice information is collected by mail questionnaires during June and July. Most freshmen receive their schedules and enrollment information prior to the first day of classes.

Currently enrolled students select their courses for the upcoming semester during Registration Week, prior to the end of each semester. The Schedule of Classes is available on-line prior to Registration Week, listing available courses along with general enrollment information. The university reserves the right to make changes to hours, units or instructional staff when such changes seem necessary or advisable. A link to the on-line "Schedule of Classes" is provided on The HUB website. Although faculty advisors are provided, it is the responsibility of students to have clearly in mind what they intend to do, what elective courses they wish to pursue and what irregularities exist which may affect their present schedule. Failed and lower-level courses are to be given priority in planning a schedule.

Students enrolled in any curriculum leading to a degree who fail any required course more than once will not be permitted to re-register in that course without the approval of the Dean of their college, the head of their department and the head of the department offering the course in question.

Students are not permitted to register in courses for which the prerequisites have not been satisfied. Exceptions to the rule may be granted only upon the recommendation of the teaching department concerned. Unless the prerequisites are satisfied or special approval is obtained when the student enters the course, no credit can be allowed for the course.

Availability of Required Courses

In order to ensure that students do not have to compete for access to their required courses, registration priority is given to students who are registering for courses in their primary major. Although the university encourages the exploration of other disciplines, access to courses outside a student's primary major (including those courses that fulfill requirements for an additional major, minor, etc.) is on a space-available basis and is not guaranteed.

Change in Schedule (Add/Drop)

To add or drop a course after Registration Week, follow the OLR instructions for Adding/Dropping a course.

Scheduling changes must be made within the period in the semester as established in the Official University Calendar. A student cannot drop a course by simply notifying the instructor(s) or by ceasing to attend class(es). A student dropping all of his/her courses (with the intent of leaving the university) must file an Application for Withdrawal or an Application for Leave of Absence (see the "Student Leave Policy," located in the University Policies section of this catalog for more information).

Undergraduate students at Carnegie Mellon may drop a course by following the instructions for dropping a course in OLR on or before the appropriate deadline as published in the Official University Calendar. This applies to all courses with the exception of half-semester mini courses. The deadline to drop a half-semester mini course is the last day of the fourth week of the mini course. When a course is dropped by these deadlines, the course is removed and does not appear on the academic record.

After the Add/Drop deadlines or to drop below 36 units, students must see their Associate Dean to facilitate schedule changes.

The Late Add Form is used for adding a course or switching sections after the established add period and during the semester in which the course is offered. Students can check Student Information On-Line to see if the appropriate schedule changes have been made. Undergraduate students who add a course or switch a section after the established add period are required to obtain the permission of their home Dean's Office or the Head of their School. If adding a course would result in a schedule overload, the permission of the student's advisor is also required. Graduate students must have the permission of their department.

- If adding a course would result in a schedule overload, the signature of the student's advisor is also required if requested by Associate Dean/Department Head.
- Graduate students must have the permission of their department.
- International students who wish to drop below full-time must consult the Office of International Education.

The deadline to add a mini course is the end of the first week of classes for that course. The deadline to drop a mini course is one week after the mid-point for that course.

Full-Time Status

Undergraduates who are registered as full-time students as of the 10th day of classes are expected to remain full-time for the duration of the semester. Full-time is defined by a minimum of 36 units. Permission to drop below the 36 unit minimum must be granted by the student's Associate Dean. Undergraduates who are registered as part-time are also subject to the above deadlines to drop or withdraw from a course.

Students carrying a full-time course load as of the 10th regularly scheduled class day are not ordinarily permitted to drop below 36 units after that time. Exceptions must be authorized by the student's Associate Dean.

Tuition Assessment

The tuition charged each student will be automatically adjusted on the 10th regularly scheduled class day (refer to the specific date noted in Official University Calendar as the "last day to add courses") based upon each student's schedule at that time. The tuition charged will be increased whenever the number of units added justifies tuition charges greater than those paid by the student at the time of fee settlement. After that time, no tuition adjustments will be made, with the exception of second minis for that particular semester.

For additional information, see the Tuition Assessment Policy in the University Policies section of this catalog.

Cross-College and University Registration Guidelines - PCHE (Pittsburgh Council on Higher Education)

Cross-registration provides opportunities for enriched educational programs by permitting full-time paying undergraduate and graduate students to cross register for one course at a Pittsburgh Council on Higher Education (PCHE) Institution. Students who are paying full-time Carnegie Mellon tuition (per the requirements of their home college) are eligible. The PCHE course may count towards full-time status. There is no additional tuition charge, except for special course or laboratory fees. Carnegie Mellon students do not acquire status at the Host Institution, but are given library and bookstore privileges. Credit and grades are transferred directly to the home institution. Cross-registration is not applicable during the Summer Session(s) or during intersessions.

There are nine approved PCHE Institutions in the Pittsburgh area:

Carlow College (412-578-6084), Chatham College (412-365-1121), Community College of Allegheny County (CCAC) (412-237-2555), Duquesne University (412-396-6230), LaRoche College (412-367-9300), Pittsburgh Theological Seminary (412-362-5610), Point Park College (412-392-3861), Robert Morris College (412-262-8256), University of Pittsburgh (412-624-7600)

"PCHE Cross Registration Request" forms are available from The HUB.

- Each college or university accepts registration from the other institutions; however, first priority is given to students of the Host Institution, and not all departments or schools in all institutions are able to participate in this program.
- In each case of a student cross-registration, the approval of the Dean or a designated individual from the home college or university must be obtained prior to registration.
- In addition, the student's advisor or Dean is responsible for assuring the student's eligibility for the course in which he/she intends to enroll.
- Full credit and grades for cross registered courses will be transferred to the appropriate institution; the academic regulations of the host university will prevail.
- The academic honesty code and other rules of conduct of the institution providing instruction apply with respect to its courses and behavior on its campus. That institution also determines whether its rules have or have not been violated. The student's own institution will impose such penalties as it considers proper when violations are reported to it.
- Cross-registrants do not thereby acquire the status of students in the institutions in which they are receiving instruction (e.g., for purposes of participation in student activities, insurance programs, etc.). They do receive library privileges at the host institution and may purchase course texts at the host bookstore.
- Each qualified student normally may enroll in no more than one course off campus in any one term or semester under this program. Students wishing to cross register for more than one course in a term must have approval from the appropriate academic offices at both schools.
- No additional tuition charge is made to students who are participating in this program; however, the student who cross registers is responsible for paying any course or laboratory fees to the host.
- Cross-registration does not apply to summer sessions or intersessions at any of the institutions.
- Adding or dropping a course after the home institution's deadline date requires permission from the home institution; adding or dropping a course after the host institution's deadline date requires permission from the host institution.

- Students enrolled in approved joint co-op programs between two PCHE institutions are exempt from the requirement of being full-time at either school in order to cross register. Students are bound by the requirements of that program.
- Carnegie Mellon students may not cross register for required courses that are normally available at Carnegie Mellon. Exceptions may be made if courses are unavailable or legitimate schedule conflicts seriously hinder completion of degree requirements within the prescribed timeframe.
- Students should not cross register in the semester in which they are graduating.

University Course Assessments (UCAs)

Students play an integral role in the academic life of the university when they participate in the evaluation of the faculty through the University Course Assessment process. UCA data is important in the evaluation of teaching and learning, as an important piece of the promotion and tenure process and as part of the process of course design and improvement. Student participation in the UCA process is critical to the university's commitment to quality teaching and academic excellence. Students are strongly encouraged to participate in the process with constructive feedback that is relevant to teaching and course content. More information on the University Course Assessment process and results from previous years can be found at the UCA website, <http://www.cmu.edu/uca>.

Finances

2006-2007 Cost of Attendance

Estimated educational expenses at Carnegie Mellon for the 2006-2007 academic year are as follows:

Freshmen - Fall 2008

Per-Unit Tuition Rate	\$543.75	
	Resident	Commuter/ Off-Campus
Tuition	\$39,150	\$39,150
Orientation Fee	190	190
Activity Fee	176	176
Port Authority Fee	78	78
Technology Fee	150	150
Media Fee	10	10
Room & Fees ^{1,2}	5,890	0
Dining	4,160	0
Totals	\$49,804	\$39,754

Undergraduate Students Who Entered Fall 2007

Per-Unit Tuition Rate	\$533.61	
	Resident	Commuter/ Off-Campus
Tuition	\$38,430	\$38,430
Orientation Fee	0	0
Activity Fee	176	176
Port Authority Fee	78	78
Technology Fee	150	150
Media Fee	10	10
Room & Fees ^{1,2}	5,890	N/A
Dining	3,850	0
Totals	\$48,584	\$38,844

Undergraduate Students Who Entered Fall 2006

Per-Unit Tuition Rate	\$513.89	
	Resident	Commuter/ Off-Campus
Tuition	\$37,000	\$37,000
Orientation Fee	0	0
Activity Fee	176	176
Port Authority Fee	78	78
Technology Fee	150	150
Media Fee	10	10
Room & Fees ^{1,2}	5,890	N/A
Dining	3,850	0
Totals	\$47,154	\$37,414

Undergraduate Students Who Entered Prior to Fall 2006

Per-Unit Tuition Rate	\$496.94	
	Resident	Commuter/ Off-Campus
Tuition	\$35,780	\$35,780
Orientation Fee	0	0
Activity Fee	176	176
Port Authority Fee	78	78
Technology Fee	150	150
Media Fee	10	10
Room & Fees ^{1,2}	5,890	N/A
Dining	3,850	0
Totals	\$45,934	\$36,194

The budgets depicted above reference a typical Resident, Commuter or Off-Campus Student. The university reserves the right to change its charges without notice.

The academic year tuition charges are for all full-time undergraduate students. A full-time student is one registered in a degree program and carrying a schedule of at least 36 units per semester. A student enrolled for less than 36 units per semester will be charged tuition on a per-unit basis.

¹ Based upon the cost of a standard double room. Your actual cost may differ.

² Room, fees and dining are not required for commuter/off campus students.

NOTE: In addition, minimal health insurance coverage is required at an estimated cost of \$870 per year, unless a waiver is granted because you are covered under your family's health plan. Premium health insurance coverage is suggested for international students at an estimated cost of \$1,806 per year. Complete information about the university's Health Insurance Policy and options, as well as the waiver requirements, is available at www.studentaffairs.cmu.edu/HealthServices/insurance.

Student Fee Information

Activity Fee - \$88 per semester - Charged to all students registered for a minimum of 18 units. This fee covers the cost of student activities and events.

Orientation Fee - \$190 - Charged to all first-time undergraduate students (fall semester only!)

Port Authority (PAT) Fee - \$39 per semester - Charged to all degree-seeking students enrolled for at least one course. This permits full access to the Port Authority Transit System.

Health Insurance Fee - \$928 annually - Minimal health insurance coverage is required at a cost of \$870 per year, unless a waiver is granted by Health Services, because you are covered under your family's health plan.

Technology Fee - \$75 per semester - Charged to all students who are eligible to enroll. This includes distance education, non-degree and exchange students. This does not include Study Abroad students. This fee is nonrefundable.

Media Fee - \$5 per semester

Billing Information

Payment of Charges

All charges and credits incurred at the university are reflected on your student account and invoice. This invoice includes tuition and fees; and may include housing, meal plan, sorority or fraternity charges, health insurance, Plaid Ca\$h, DineXtra and any miscellaneous charges incurred. Miscellaneous charges could include but are not limited to music lessons, library fines, parking fines, pharmacy fees or emergency loans.

Note: The information on the invoice is accurate as of the day of printing.

A student account invoice is mailed in July for the fall semester and in November for the spring semester. Payment is due on or before August 15, 2008 and January 5, 2009 for the 2008-2009 academic year. Balances not paid in full on or before the Monday prior to the start of classes will be assessed a Late Enrollment fee of \$150.

Your account can be paid via personal check, cash, wire transfer, scholarships or loan proceeds. You may also contract a payment plan through Tuition Management Services (TMS) - see the following page for additional information. **Enrolled students may pay by e-check via Student Information On-Line (www.cmu.edu/hub).**

Payment Options

E-Pay with E-Check:

Enrollment Services encourages you to take advantage of this convenient way to pay your student account. Electronic Check Payment is available to currently enrolled students at Carnegie Mellon. This electronic check payment process allows a student to pay the current semester and future student account balances via an automatic direct debit to a U.S. checking or savings account. This authorization will be made from a secure student account payment website within Student Information On-Line on the Aid/Account Page. Enrollment takes one day to set up.

You will need the following information in order to complete the E-Pay Enrollment Process:

- Account Type and Number (checking or savings)
- Transit routing number

E-Refund:

Enrollment services encourages all students to authorize direct deposit of their student account credit balances into a checking or savings account. Taking advantage of this opportunity eliminates the need to stand in line at The HUB to pick up a check. To enroll, students simply visit the account page on Student Information On-Line and click the E-Pay/E-Refund button. **E-Refunds can only be initiated by Enrollment Services.**

Sponsor Checks & Scholarship Checks:

Sponsor checks and/or scholarship checks **MUST** be sent to Enrollment Services, Carnegie Mellon, Warner Hall A19, 5000 Forbes Avenue, Pittsburgh, PA 15213-3890.

Cash or Check Payments at The HUB:

Students and parents may make payments in person at The HUB, using cash or a check. Students paying by check should include their name and Andre ID/SIO User ID on the memo line of the check. Additionally, students using starter checks should also include their local address and telephone number.

Check Payments via Mail:

When paying by check, write the student's name and Andrew ID/SIO User ID on the memo line of the check. **If you send a check to this address, you must attach the bottom portion of your invoice. DO NOT attach any additional information to your invoice.**

Make checks payable to *Carnegie Mellon* and send to our lockbox:

Carnegie Mellon
P.O. Box 360224
Pittsburgh, PA 15251-6224

SEND CHECKS ONLY TO THE P.O. BOX. DO NOT ATTACH OTHER PAYMENTS, CORRESPONDENCE, ETC. WE WILL NOT RECEIVE THE ADDITIONAL INFORMATION.

Wire Transfer Payments

The following information is required when sending a wire transfer payment:

Bank of New York Mellon, 500 Ross St., Pittsburgh, PA 15262
Routing Number: 043-000-261
Carnegie Mellon Account Number: 197-9003
Student Name and ID Number
SWIFT Number: MELNUS3P

Carnegie Mellon is not responsible for wire transfer payments that are not properly identified. Allow at least 10-14 business days for processing. All unidentified wire transfers will be returned to sender.

Tuition Management Systems Monthly Payment Plan

The Carnegie Mellon Tuition Payment Plan administered by Tuition Management Systems (TMS) is recommended to help you budget payment of your educational expenses and limit your debt.

The Carnegie Mellon Tuition Payment Plan allows you to spread your payments out over 10 months. There is no interest charged on the plan, and a variety of other benefits, including Life Insurance, are provided, all paid for with a single low annual fee. A semester option at a lower fee is available for those graduating in December or beginning their enrollment in the spring semester.

Benefits of the Carnegie Mellon Tuition Payment Plan include:

- Interest-free payments
- Life Insurance coverage for the bill payer
- Toll-free telephone service during extended personal service hours at 888-251-3533
- BorrowSmart Affordability Planning and Counseling with friendly and professional Education Payment Counselors.
- A wide variety of payment methods, including personal checks, money orders, credit cards, Western Union by wire or check, and automated payments from a checking or savings account.
- 24-hour access to account information at www.afford.com
- 24-hour access to account information in a toll-free InfoLine

Visit www.afford.com for more information on payment options, Carnegie Mellon education loans, free education payment counseling and the many payment options we offer to help you afford a Carnegie Mellon education. You may also contact a TMS Education Payment Counselor at 1-800-895-9061 Monday-Friday, 8:00 a.m. to 10:00 p.m. and Saturday, 9:00 a.m. to 3:00 p.m. (EST).

Monthly payment plan overpayments will be refunded in April.

Financial Assistance

Prospective Students: Office of Admission, Warner Hall 101

Current Students: The HUB, Warner Hall A-19

Financial Assistance Principles

Carnegie Mellon allocates resources carefully and judiciously to the benefit of the high-quality students we seek to enroll in the university. Financial aid, viewed by many as an entitlement when federal resources were much more plentiful, is now awarded by institutions who must balance resources, goals and priorities while attracting the highest quality students.

Like many other colleges and universities, we use an increasingly larger share of our limited resources to help families cover the cost of enrollment. Federal and state financial aid resources, awarded on the basis of financial need, are distributed under federal and state guidelines.

Our merit-based financial aid strategy is aimed at rewarding the highest quality students. It aids high-quality students from middle-income families who may not have qualified for financial aid if it were awarded solely on the basis of financial need.

Applying for Financial Assistance

Carnegie Mellon follows a need-blind admission policy, which means we don't admit students based on their families' ability to pay for their education. Applying for financial aid will have no effect on your chances for regular admission. It may have an affect; however, on those students we are able to admit from the waiting list. We will determine your eligibility to receive a financial aid package – a combination of federal, state and Carnegie Mellon funds.

To Apply for Financial Aid

To receive financial aid consideration, follow these steps:

1. Complete a Free Application for Federal Student Aid (FAFSA). The FAFSA is available on-line at www.fafsa.ed.gov. This document is necessary if you wish to be considered for any student aid.
2. Prior to completing the FAFSA or Renewal FAFSA on the web, you need to request a Personal Identification Number (PIN) from the Department of Education. If you are a dependent, undergraduate student, your parent must also request a PIN in order to electronically sign your FAFSA or Renewal FAFSA.¹ Request a PIN by visiting <http://pin.ed.gov>. If you already have a PIN, you do not need to request a new one. If you have lost or forgotten your PIN, you need to request that it be sent to you again. If you think someone knows your PIN, select the Change PIN option to request a new PIN combination.
¹Your PIN serves as an electronic identifier and allows you to electronically sign and immediately transmit the FAFSA.
3. Complete the Carnegie Mellon Financial Aid Application. There are two options for completing this form:
 - On Line - You must have an Andrew UserID and password to complete this application.

- PDF version - You may download this form from The HUB Website.

Additional information is published on The HUB Website, including specific instructions and required documents.

4. Parent(s)' U.S. Federal Income Tax Return or Foreign Tax Return and W-2 Wage and Tax Statement(s)

Please send us a signed copy of your parent(s)' actual Federal Income Tax Return, pages 1 and 2 only. We will not accept a tax preparer's stamp in place of any signature(s). We will accept a tax preparer's signature. We also require legible copies of all parental W-2 Wage and Tax Statement(s). Print your name and Student ID Number in the upper right corner of each tax document. Do not submit a copy of their prior year or an estimated tax return. If you file electronically, you are required to submit to us a signed copy of your electronic tax return. All documents listed above are due to us on or before April 15. If your parent(s) are required to file a Federal Income Tax Return in a country other than the United States, you must provide us with a copy of their foreign tax return and provide tax information translated into U.S. dollars on a U.S. Federal Income Tax Return. This document must be signed by your parent(s) and a tax accountant.

5. Student's/Spouse's U.S. Federal Income Tax Return or Foreign Tax Return

We also require a signed copy of your actual Federal Income Tax Return. We will not accept a tax preparer's stamp in place of any signature(s). We will accept a tax preparer's signature. Do not submit a copy of the prior year or an estimated tax return. If you file electronically, you are required to submit to us a signed copy of your electronic tax return. All documents listed above are due to us on or before April 15.

If you are required to file a Federal Income Tax Return in a country other than the United States, you must provide us with a copy of your foreign tax return and provide tax information translated into U.S. dollars on a U.S. Federal Income Tax Return. This document must be signed by you and a tax accountant.

Financial Aid Award Package

To help meet your financial need, we offer you a combination of awards called a financial aid award package. There are two components to most financial aid packages: gift aid and self-help. Gift aid awards include grants and scholarships and are monies given to you that you do not have to repay. Self-help awards are monies you must apply for and either repay (student loans) or work for (student employment).

Financial aid award packages are structured to meet the particular needs of our students. The amount of financial aid may vary with need as the student progresses through the undergraduate program. Returning students financial aid award packages are evaluated and renewed by the Assistant Directors in The HUB annually upon proper resubmission of application materials by April 15, continued evidence of financial need, and satisfactory academic progress.

Note: If your Expected Family Contribution (EFC) is greater than the cost of attendance, you will not be offered need-based financial aid. You or your parent(s) may still apply for non-need-based aid, such as the Federal PLUS Loan and the unsubsidized Federal Stafford Loan.

Award Notification Letter

Once your financial aid package has been determined, we will mail a Financial Aid Award Letter to your permanent address. This letter contains important information and instructions regarding your financial aid package. If your financial aid package changes at any point throughout the academic year, you will receive a revised Financial Aid Award Letter.

Satisfactory Academic Progress

Federal Title IV - The Federal Department of Education requires that Federal Title IV Financial Assistance recipients meet academic progress standards each year. Federal Title IV Financial Assistance includes the Federal Pell Grant, Federal Supplemental Educational Opportunity Grant, Federal Perkins Loan, Federal Work-Study, Federal Stafford Loan and Federal PLUS Loan programs. Each university determines its own policy regarding sufficient progress standards.

Federal academic progress standards must include two elements: cumulative QPA and cumulative units. At Carnegie Mellon, we define this as follows: first-year freshman students must pass 80 percent of all cumulative units attempted at Carnegie Mellon and have a 1.75 cumulative QPA after the first year; all other students (excluding graduate students in Tepper and Heinz) must pass 80 percent of all cumulative units attempted at Carnegie Mellon and have a 2.00 cumulative QPA.

Carnegie Mellon Academic Scholarships - Institutional Academic Scholarships are awards that you do not have to repay. The Carnegie Mellon Institutional Academic Scholarships are awarded to students when they enter as freshmen and are renewed annually if the student meets the cumulative 2.0 QPA requirement. These scholarships are renewable for eight semesters of undergraduate education (ten semesters for Architecture students), provided satisfactory academic performance is maintained and the student is assessed Carnegie Mellon tuition.

Appeal Process - Carnegie Mellon realizes that extenuating circumstances may contribute to a student's inability to achieve satisfactory academic progress, and thus we encourage students to appeal after receipt of progress failure notification. Appeal examples include; extended illness, changes in major, difficult transition to first-year in college (academically and socially), recent diagnosis of learning disability or a recent death of a close family member.

For More Information

An excellent, detailed source of information regarding financial assistance programs available at Carnegie Mellon is the Undergraduate Student Financial Assistance Guide for the current academic year. This publication is available on The HUB Website.

If you have any questions or need assistance, contact an Assistant Director of Enrollment Services at The HUB.

Types of Financial Assistance Available

Grants

Grants are awards you do not have to repay. All federal, state and other institutional grants and scholarships are awards based upon financial need.

Federal Pell Grant

A Federal Pell Grant is a grant awarded by the federal government to students with high financial need. The projected maximum grant awarded for the 2008-09 academic year is \$4,731. If you become eligible for a Federal Pell Grant after your financial aid package is determined, a dollar-for-dollar reduction to your Carnegie Mellon need-based grant funds will occur.

Federal Supplemental Educational Opportunity Grant (Federal SEOG)

A Federal SEOG is a grant for undergraduates with exceptional financial need. Carnegie Mellon usually awards these grants to students who receive a Federal Pell Grant. If there is a change in your Federal SEOG eligibility, a dollar-for-dollar adjustment to your Carnegie Mellon need based grant funds will occur.

Carnegie Mellon Undergraduate Grant

A Carnegie Mellon Undergraduate Grant is a grant awarded by Carnegie Mellon to students who have financial need. Once you complete the Carnegie Mellon financial aid process, you are considered for this grant. Note: This grant is not automatically renewed each year.

State Grants

Some states provide educational grants to their residents who demonstrate financial need.

If you are eligible for grant assistance from your state but you do not apply, Carnegie Mellon will not provide additional grant assistance to replace your lost state grant funds. In addition, if you do not apply on time for State Grant assistance and you are a Pennsylvania resident; we will reduce your eligibility for the Carnegie Mellon Undergraduate Grant by \$1,000 if you would have been eligible for a PHEAA State Grant. This is the amount of institutional grant assistance Carnegie Mellon would have received from the Pennsylvania Higher Education Assistance Agency (PHEAA) if you had applied on time.

If you are awarded a state grant after your financial aid package is determined, a dollar-for-dollar reduction to your Carnegie Mellon need based grant funds will occur.

Scholarships

Scholarships are awards that you do not have to repay. The Carnegie Mellon Institutional Academic Scholarships are awarded to students when they enter as freshmen and are renewed annually if the student meets the cumulative 2.0 QPA requirement.

Carnegie Mellon Academic Scholarship Program

Carnegie Mellon offers several academic scholarships to incoming freshmen. The scholarships are designed to recognize and reward outstanding academic, artistic and personal achievement.

Financial need is not a requirement. These scholarships are renewable for eight semesters of undergraduate education (*ten semesters for Architecture students*), provided satisfactory academic performance is maintained and you are assessed Carnegie Mellon tuition. **Academic scholarships are only awarded to incoming freshmen during the admission process.** These scholarships include: Judith Resnik Challenger Scholarship, Andrew Carnegie Scholarship and Presidential Scholarship. Recipients do not have to file a FAFSA to renew these scholarships unless they wish to apply for need-based financial aid. If your parent is a Carnegie Mellon employee who qualifies for tuition remission, you will **not** be eligible for a Carnegie Mellon Academic Scholarship.

Outside Scholarships

Outside scholarships do not affect Carnegie Mellon academic scholarships unless the total amount of grants and scholarships exceeds the total amount of tuition, fees, standard room and standard dining. Please refer to the following website for more information: www.cmu.edu/hub/fa/fa_scholarships.html.

Student Loans

Student loans are self-help awards which must be repaid. Regardless of our recommended lenders, we will process any loan from any lender, federal or alternative.

Federal Perkins Loan

A Federal Perkins Loan is a low-interest (5 percent) federal loan administered by Carnegie Mellon. Carnegie Mellon offers this loan to students who have exceptional financial need as determined by Federal Methodology and Carnegie Mellon. You receive consideration for a Federal Perkins Loan if you complete a FAFSA and a Carnegie Mellon Financial Aid Application. There is no separate application for this loan. Enrollment Services will automatically credit the loan to your student account (one-half in the fall, one-half in the spring).

If you are offered a Federal Perkins Loan, Enrollment Services will mail you a Promissory Note in mid to late summer. You must sign and return your Promissory Note to Enrollment Services. If you do not return a signed Promissory Note, your Federal Perkins Loan will be canceled.

Repayment of both principal and interest does not begin until nine months after you graduate or are no longer enrolled at least half-time (18 units per semester). No interest accrues on the loan until you begin repayment.

Federal Stafford Loan

A Federal Stafford Loan (FSL) is a loan given by a private lender (e.g., bank, credit union, or other financial institution) to students. There are two types of Federal Stafford Loans — subsidized and unsubsidized. The interest rate for subsidized loans is 6.0% for loans first disbursed on or after July 1, 2008 and before June 20, 2009. The interest rate for unsubsidized loans is fixed at 6.8%.

You may borrow up to the following annual loan limits (subsidized and unsubsidized FSL combined) based upon your year of study:

- first-year students \$3,500; sophomores \$4,500;
- juniors, seniors and fifth-year students \$5,500.

The maximum is \$23,000 for undergraduate study.

To apply for an FSL, you must complete and submit the following:

- FAFSA
- Carnegie Mellon Financial Aid Application
- Signed copy of your parent(s)' Federal Income Tax Return or Foreign Income Tax Return
- Your parents' W-2 Wage and Tax Statements
- Signed copy of your Federal Income Tax Return or Foreign Income Tax Return

You must complete a Stafford Master Promissory Note (MPN). If you previously borrowed a Federal Stafford Loan (FSL) and completed a Master Promissory Note, you do not need to complete another MPN for each subsequent academic year. Your FAFSA will serve as your application.

If you are a first-time borrower at Carnegie Mellon, you must complete a Stafford MPN on-line. Complete instructions are available on The HUB website: www.cmu.edu/hub/mpn.html.

In most cases, your FSL funds will be electronically deposited into your student account at Carnegie Mellon on or about September 2 for the fall semester, and on or about January 2 for the spring semester. In some cases, you may be required to sign your FSL check in The HUB before the loan proceeds can be credited to your student account. You should subtract approximately one-half of your annual FSL from the balance due appearing on your Fall and Spring Invoices.

No fees will be deducted from your loan if you are borrowing from a KeystoneBEST Lender. Our preferred Keystone Best Lenders are PNC Bank and Citizens Bank.

Subsidized Federal Stafford Loan

A subsidized Federal Stafford Loan (FSL) is a loan given by a private lender (e.g., bank, credit union or other financial institution) to students with financial need. You begin repaying the loan six months after you either graduate or cease to be enrolled at least half-time (18 units per semester). The interest on a subsidized FSL is paid by the federal government while you remain enrolled at least half time and during your six-month grace period. You have up to 10 years to repay your loan.

Unsubsidized Federal Stafford Loan

An unsubsidized Federal Stafford Loan (FSL) is available to students who do not qualify, in whole or in part, for a subsidized Federal Stafford Loan. It is not based on financial need. Unlike the subsidized FSL, you are required to pay the interest that accumulates on the unsubsidized FSL every three months while you are in school. It is possible to have the interest capitalized (instead of paying the interest every three months, it is added back to the principal). This will increase the amount you have to repay. We suggest you pay the interest as it accumulates, as you'll repay less in the long run.

You may be eligible for additional unsubsidized FSL funds (beyond the FSL limits stated above) if your parent(s) apply for a Federal PLUS Loan and are denied. If this is the case, the maximum you may borrow annually in additional unsubsidized FSL funds based upon your year of study is as follows:

- first-year students \$4,000; sophomores \$4,000;
- juniors, seniors and fifth-year students \$5,000.

The aggregate total (subsidized, unsubsidized and additional unsubsidized FSL combined) is \$46,000 for undergraduate study; however, only \$23,000 of this total can be in subsidized FSL funds.

Federal Entrance Loan Counseling

Federal regulations require that all first-time federal student loan borrowers complete an entrance counseling session prior to their Federal Student Loan funds being credited to their student accounts. During the entrance counseling session, you will be informed of your rights and responsibilities as a borrower.

CARNEGIE MELLON WILL NOT PROCESS YOUR FEDERAL STAFFORD LOAN UNTIL YOU COMPLETE THE ENTRANCE COUNSELING SESSION.

Complete the loan counseling requirements electronically on our Federal Entrance Loan Counseling Website www.cmu.edu/hub. Follow the instructions, answer the questions and complete the appropriate electronic submission form. We recommend that you print a copy of the "Rights and Responsibilities Checklist."

Prior to the form appearing in the browser, you will need to log into the server by entering your Andrew UserID and Password. We recommend Microsoft Internet Explorer version 5.0 or newer. America Online's browser will not work. If you have questions regarding your account information, please contact Computing Services at 412-268-4357.

Federal PLUS Loan

A Federal PLUS Loan is a non-need-based loan given by a private lender (e.g., bank, credit union or other financial institution) to creditworthy parent(s). **The interest rate is fixed at 8.5%. Interest starts to accrue at disbursement**, however full repayment of principal and interest begins 60 days after the last disbursement for the loan period. The maximum repayment period is 10 years.

Parent(s) may apply for a Federal PLUS Loan for up to the annual cost of attendance minus any financial aid. Approval for this loan and the amount a parent is eligible to borrow is determined by the lender. If the Federal PLUS Loan is not approved by the lender,

the student may borrow additional unsubsidized FSL funds (see Unsubsidized Federal Stafford Loan).

If the Federal PLUS Loan is approved by the lender, Federal Origination and Default Fees (3 percent) are deducted from the loan proceeds each semester before being sent to Carnegie Mellon. The proceeds will be sent to us via electronic funds transfer (EFT) or by check. If the funds are disbursed via EFT, they will be electronically deposited into your student account at Carnegie Mellon. If the funds are sent to us by check (made co-payable to your parent and Carnegie Mellon), Enrollment Services will send the check to your parent to be endorsed and returned to Enrollment Services to be deposited into your student account at Carnegie Mellon.

New for 2008-2009: Students who do not apply for financial aid but whose parents plan to borrow a Federal PLUS Loan are required to complete a FAFSA.

All parents wishing to borrow a Federal PLUS Loan for the first time are required to complete a Federal PLUS Master Promissory Note (MPN). If the parent who will be a first-time borrower of a Federal PLUS Loan has a U.S. Department of Education PIN, he or she may complete the Federal PLUS MPN online. Additional Information is available at www.cmu.edu/hub/plus_mpn.html.

Parents who previously borrowed through the Federal PLUS Loan Program and wish to reapply must complete the Federal PLUS pre-approval process online.

Alternative Loans

A complete list of Carnegie Mellon's recommended alternative loan lending partners, including borrower benefits, is available online at http://www.cmu.edu/hub/fa/fa_main.html. **Regardless of our recommended lenders we will process any loan from any lender, federal or alternative.**

Student Employment

There are many student employment opportunities on campus, both need-based and non-need-based.

Federal Work Study (FWS) is a need-based self-help award. If you have been awarded FWS, your FWS award is the total that you can earn during the academic year as a work-study student. *Funds earned in the Federal Work Study Program are not credited to your student account.*

Federal Community Service:

Students who are awarded Federal Work Study are eligible to use their award to work off-campus for one of our Federal Community Service Employers. Federal Community Service positions are posted on Carnegie Mellon's TartanTrak at <http://www.studentaffairs.cmu.edu/career/tartantrak.html>.

If you have not been awarded FWS and wish to work on campus, there are positions available. Both need-based and non-need-based student employment positions are advertised on the Career Center's web page: www.studentaffairs.cmu.edu/career/tartantrak.html.

All undergraduates who are employed by Carnegie Mellon complete timecards and are paid by check on a bi-weekly basis. Students have the option to have their pay direct deposited into a local checking or savings account. The authorization form may be found on the payroll website: <https://www.as.cmu.edu/~fsg/forms/forms.htm>.

Reserve Officer Training Corps (ROTC) Scholarships

Air Force ROTC

Type I Award: covers full tuition and fees. Type II Award: \$15,000 annually. Type VIII Award: 80% of tuition. There is a book allowance of \$510, and a monthly stipend (\$250 - freshmen; \$300 - sophomores; \$350 - juniors; \$400 - seniors). Stipends are calculated for 9 months for the Air Force because they use the University of Pittsburgh academic calendar.

Students on scholarship are required to attend AFROTC courses (for more information see page 82).

Army ROTC

Army ROTC offers four, three and two year full tuition and fee scholarships with additional annual allowances of \$900 for books and a monthly stipend (\$300 - freshmen; \$350 - sophomores; \$450 - juniors; \$500 - seniors). Army stipends are calculated for 8 months using Aug. 30 to April 26.

High school, undergraduate and incoming two-year graduate students are eligible to apply. For application and information call ROTC at the University of Pittsburgh at (412) 624-6197/6198/6199 (for more information see page 82).

Navy-Marine Corps ROTC

The NROTC offers four-, three- and two-year scholarships based on competitive national selection. The Navy pays for tuition and fees. There is an annual book allowance of \$750, and a monthly stipend (\$250 - freshmen; \$300 - sophomores; \$350 - juniors; \$400 - seniors) with an additional transportation allowance. In addition, NROTC midshipmen receive full active duty pay and benefits while on summer training cruises. Navy stipends are based upon 9 months using the Carnegie Mellon calendar.

Special scholarships are available to minority students and students who are interested in careers as nuclear power officers. These special scholarships are available to students who have completed at least one term of academic college course work. See page 83 for more information.

Financial Aid Policies

University Academic Scholarship Renewals

Carnegie Mellon University awards academic scholarships as part of the freshman financial aid process. Each of these scholarships is renewable for four academic years of study (five for architecture) based upon the maintenance of a specific cumulative quality point average. The academic scholarship renewal criteria are included in the scholarship notification letter which is mailed to the student prior to the May 1 matriculation deadline.

Each scholarship recipient's cumulative quality point average is reviewed at the end of each academic year. If the student achieves the scholarship renewal criteria, then the scholarship is automatically renewed for the next academic year.

If the student does not meet the cumulative quality point average requirement for renewal, then s/he is given the opportunity to appeal. A merit scholarship appeal form and instructions are automatically sent to the student at the end of each academic year.

The student's completed appeal form is reviewed by members of the Enrollment Services staff. Input from the Associate Dean of the student's college is also considered. The student is notified, in writing, of the decision. The decision may be to renew the scholarship for the entire academic year, renew the scholarship for one academic term, or to reject the appeal. If the appeal is rejected, a written explanation is provided to the student.

Satisfactory Academic Progress

The Department of Education requires recipients of Federal Title IV Financial Assistance to meet academic progress standards each year. Federal Title IV Financial Assistance includes the Federal Pell Grant, Federal Supplemental Educational Opportunity Grant, Federal Perkins Loan, Federal Work-Study, Federal Stafford Loan and Federal PLUS Loan Programs. Each university determines its own policy regarding sufficient progress standards. Federal academic progress standards must include two elements: cumulative QPA and cumulative units. At Carnegie Mellon, we define this as follows: first-year freshman students must pass 80 percent of all cumulative units attempted at Carnegie Mellon and have a 1.75 cumulative QPA after the first year, all other students (excluding graduate students in the Tepper School of Business and Heinz) must pass 80 percent of all cumulative units attempted at Carnegie Mellon and have a 2.00 cumulative QPA.

Outside Scholarship and/or a State or Federal Grant

Outside scholarships do not affect Carnegie Mellon academic scholarships unless the total amount of grants and scholarships exceeds the total amount of tuition, fees, standard room and standard dining.

In the case of federal and state grants that were not included in our initial award, a dollar-for-dollar reduction of the need based institutional grant/scholarship funds will occur.

The first \$6,000 you receive in outside grants/scholarships will not reduce your Carnegie Mellon gift aid. In some cases, self-help aid (loans and work study) will be adjusted. If you receive more than \$6,000 annually in outside grants/scholarships, your need based Carnegie Mellon grants/scholarships will be reduced by one-half the value that exceeds \$6,000.

Students Pursuing a Second Bachelor's Degree

If you are enrolling in a second bachelor's degree program, you are not eligible for grants/scholarships. However, you may be eligible to receive funds from student loan and student employment programs. Eligibility for student loan funds is contingent upon the student's prior loan indebtedness.

Undergraduate Tuition Exchange Programs

Carnegie Mellon University assesses the standard tuition charge for the undergraduate tuition exchange programs.

Since Carnegie Mellon assesses the tuition charge, the student can be considered for all forms of institutional, state, and federal aid for which the student may have eligibility with the exception of any student employment program.

Undergraduate Study Abroad Programs

Carnegie Mellon University does not assess the tuition charge for any of the Study Abroad Programs.

Since Carnegie Mellon does not assess the tuition charge, the student is not considered for any institutional grants and scholarships. However, Carnegie Mellon will consider any student participating in an approved Study Abroad Program for all state and federal student aid programs for which the student may have eligibility with the exception of any student employment program.

The U.S. Department of Education and Carnegie Mellon University define an approved Study Abroad Program as one which is part of a contractual agreement between Carnegie Mellon and the host institution. Additionally, courses taken in the Study Abroad Program must be accepted for transfer to Carnegie Mellon by the Dean of the student's college.

Undergraduate Sponsored Study Abroad Programs

Carnegie Mellon assesses full tuition charges and all applicable fees to students participating in an undergraduate sponsored study abroad program.

Undergraduate International Students

Documentation Eligibility (U.S. Citizenship or Eligible Noncitizen)

You must be a U.S. Citizen or permanent resident alien to receive federal student aid. If you are a U.S. Citizen, but were not born in the United States, valid documentation includes a copy of your passport or naturalization certificate.

If you are a U.S. permanent resident alien or refugee, acceptable forms of verification include a photocopy of both sides of your I-551 or I-551C card.

Undergraduate international students are ineligible to receive any federal or state student financial aid. Additionally, Carnegie Mellon does not award any institutional financial aid funds to undergraduate international students.

Other Sources for Enrollment-Related Information

The HUB Website contains the most up-to-date enrollment related information for Carnegie Mellon students. It is accessible 24-hours a day at www.cmu.edu/hub.

A complete calendar of important dates and deadlines for the academic year can be found on the HUB website, <http://www.cmu.edu/hub>.

Additionally, Enrollment Services publishes many different guides and brochures throughout the academic year in order to provide detailed information pertaining to financial assistance, student accounts and registration.

If you have questions about any facet of your enrollment, you should contact an Assistant Director of Enrollment Services, in The HUB, Monday, Wednesday, and Friday between 8:30 a.m. and 4:30 p.m. or Tuesday or Thursday between 10:30 a.m. and 4:30 p.m. Extended hours may be offered during orientation week, and will be announced on The HUB Website.

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University Policies

http://policy.andrew.cmu.edu/univ_policy/

Policy on Cheating and Plagiarism

Students at Carnegie Mellon are engaged in preparation for professional activity of the highest standards. Each profession constrains its members with both ethical responsibilities and disciplinary limits. To assure the validity of the learning experience a university establishes clear standards for student work.

In any presentation, creative, artistic, or research, it is the ethical responsibility of each student to identify the conceptual sources of the work submitted. Failure to do so is dishonest and is the basis for a charge of cheating or plagiarism, which is subject to disciplinary action.

Cheating includes but is not necessarily limited to:

1. Plagiarism, explained below.
2. Submission of work that is not the student's own for papers, assignments or exams.
3. Submission or use of falsified data.
4. Theft of or unauthorized access to an exam.
5. Use of an alternate, stand-in or proxy during an examination.
6. Use of unauthorized material including textbooks, notes or computer programs in the preparation of an assignment or during an examination.
7. Supplying or communicating in any way unauthorized information to another student for the preparation of an assignment or during an examination.
8. Collaboration in the preparation of an assignment. Unless specifically permitted or required by the instructor, collaboration will usually be viewed by the university as cheating. Each student, therefore, is responsible for understanding the policies of the department offering any course as they refer to the amount of help and collaboration permitted in preparation of assignments.
9. Submission of the same work for credit in two courses without obtaining the permission of the instructors beforehand.

Plagiarism includes, but is not limited to, failure to indicate the source with quotation marks or footnotes where appropriate if any of the following are reproduced in the work submitted by a student:

1. A phrase, written or musical.
2. A graphic element.
3. A proof.
4. Specific language.
5. An idea derived from the work, published or unpublished, of another person.

Computing and Information Resources

Code of Ethics

The ethical principles which apply to everyday community life also apply to computing. Every member of Carnegie Mellon has two basic rights: privacy and a fair share of resources. It is unethical for any other person to violate these rights.

Privacy

- On shared computer systems every user is assigned an ID. Nobody else should use an ID without explicit permission from the owner.
- All files belong to somebody. They should be assumed to be private and confidential unless the owner has explicitly made them available to others.
- Messages sent to other users should always identify the sender.
- Network traffic should be considered private.
- Obscenities should not be sent by computer.
- Records relating to the use of computing and information resources are confidential.

Resources

- Nobody should deliberately attempt to degrade or disrupt system performance or to interfere with the work of others.
- Loopholes in computer systems or knowledge of a special password should not be used to alter computer systems, obtain extra resources, or take resources from another person.
- Computing equipment owned by departments or individuals should be used only with the owner's permission.
- University resources are provided for university purposes. Any use of computing for commercial purposes or personal financial gain must be authorized in advance. Many of the agreements that the university has specifically forbid this activity.
- Computing and information resources are community resources. Theft, mutilation, and abuse of these resources violate the nature and spirit of community and intellectual inquiry.

System Administration

- On rare occasions, computing staff may access others' files, but only when strictly necessary for the maintenance of a system.
- If a loophole is found in the security of any computer system, it should be reported to the system administrator and not used for personal gain or to disrupt the work of others.
- The distribution of programs and databases is controlled by the laws of copyright, licensing agreements, and trade secret laws. These must be observed.

This code of ethics lays down general guidelines for the use of computing and information resources. Failure to observe the code may lead to disciplinary action. Offenses that involve academic dishonesty will be considered particularly serious.

Policies on Examinations

Preamble

The Faculty Senate adopted the following policies on the administration of examinations for the undergraduate courses (defined as courses that are numbered 6xx or below). These policies represent an understanding between faculty and student concerning an important but often stressful period, especially at the conclusion of each academic semester and at mid-semester. There should be no expectation that the following points will cover every conceivable situation. The student should anticipate the demands of the exam schedule, plan accordingly and early, and be prepared. The faculty should recognize that the student is encumbered with many tightly orchestrated and intensive obligations during this period over which he or she has no control: expectations should be reasonably consistent with the number of course units and, of course, should be made known to the student well in advance of the final examination period, preferably as part of the course syllabus.

In order to help students plan their time and study optimally for examinations, this document lays out in some detail the policies regarding final and in-term examinations. Instructors are requested to provide notification of the major in-term examinations in the course syllabus. The final examination date is posted early in the semester. It is the responsibility of the student to give his or her instructor sufficient notice and to work with the instructor to reschedule examinations if this is needed.

Definitions

- Final examination period. The university's official final examination period begins on the Monday immediately following the last day of classes and continues through the last day of scheduled final examinations, with the exception of reading day(s).

- Scheduled final examinations. Scheduled final examinations are those scheduled by Enrollment Services.
- Self-scheduled examinations. An instructor may choose not to fix a schedule for the final examination, but instead allow each student to choose the examination time; such exams are called self-scheduled examinations.
- Final examinations. Final examinations can either be comprehensive, covering all course materials, or noncomprehensive, covering only a part of the course.
- In-term examinations. Major examinations during the semester are referred to here as in-term examinations.

I. In-Term Examinations

1. All in-term examinations should be given during the regularly scheduled class time. However, if the exam requires additional time to complete, then examinations may be administered outside of regularly scheduled class time.
2. No examinations given outside of class time (excluding make ups and self-scheduled examinations) shall be administered on a Friday after 4:30 pm, or at any time Saturday or Sunday.
3. The instructor administering an exam (or another required class event) that falls outside class time must make any and all reasonable accommodations to provide an alternative time to students who have conflicts with the proposed time period, including those conflicts due to activities, meetings, other classes, etc. (provided that the instructor is notified of such conflict in a timely manner).
4. No student shall be required to take more than two full-period in-class or out-of-class examinations on the same day. It is the responsibility of the student to notify the instructor in a timely manner of his/her circumstance so that appropriate accommodations can be made.

II. Final Examinations

1. All scheduled final examinations are held at the end of the semester during the university's official final examination period. Comprehensive final examinations are not required for each course, but are given at the option of the department or instructor. The reading day and weekend preceding the examination days shall never be used for examination purposes of any kind, unless a student opts to take a self-scheduled examination during this time. Non-comprehensive final examinations or final projects (but not both) are allowed during this final examination period only in courses that do not give a final comprehensive examination.
2. Instructors are expected to return all work assigned no later than the last regular day of classes in courses for which there is a final examination. In cases when this is not possible, an answer key, solution sets or equivalent feedback should be provided unless the final examination will not cover material in work that has not been returned.
3. No other coursework, including laboratory or studio work, will be due during the final examination period unless it is assigned in advance and in lieu of the course's final examination. Regardless of whether there is a final examination in the course, no classes other than review sessions shall be held during the final examination period. Review sessions should be scheduled for optimal attendance, and a serious effort should be made to accommodate students who cannot attend. In appreciation of the time required to prepare for final examinations, no other examinations, portfolio reviews, critiques or juries shall be scheduled for the last class day of a course with a final examination.
4. Instructors shall never exert or submit to pressures to move an examination so that people can leave earlier nor pressure students to take an examination on a reading day or weekend preceding examinations.
5. No student is required to take more than two scheduled examinations that start within a 25-hour period. A student who has more than two examinations scheduled within a 25-hour period or has two examinations scheduled at the same time should first contact the instructors of the courses for assistance in resolving conflicts. If the problem cannot be resolved by that means, the student should contact the associate dean of his or her home college.
6. Take-home final examinations shall be given for any 24-hour

period of the student's choosing during the final examination period.

7. Students are expected to present themselves at the place assigned at the start of the examination; late arrival will reduce the total time a student has to complete the examination, unless instructor's course policy indicates otherwise. Instructors reserve the right to require attendance within a specific time period. Students who miss an examination with a reasonable excuse and wish to petition for a make-up final examination should check with the instructor. Instructors are encouraged to include late arrival policy and make-up exam policy in the course syllabus.
8. Any student shall be permitted to review his or her corrected, graded final examination in the presence of an instructor or a teaching assistant. Any controversy arising from this review shall be dealt with in accordance with the university procedure for the appeal of grades and academic actions. A final examination that is not returned to a student will be kept available for a year for review. In the event that the instructor or teaching assistant is not available for the review, the responsibility shall rest with the department head of the instructor offering the course or his or her designee. Since instructors are expected to return all work assigned before the final examinations, they are not responsible for retaining unclaimed coursework.
9. Concerns related to final examination, complaints about violations of the final examination policy or alterations of the final examination schedule should be directed to the department head of the instructor offering the course or to the associate dean of the student's home college.

Contact:

Questions concerning this policy or its content should be directed to the Vice Provost for Education, x8-5865.

Student Health Insurance Policy

Reason for Policy

The high cost of health care in the United States presents a potentially serious health and financial risk to students and their accompanying dependents. The absence of adequate insurance coverage can result in temporary or permanent interruption of a student's education. The university is committed to offering student health insurance that provides access to quality health care and achieves a balance between premium cost and adequate coverage without overburdening students' financial resources. This balance is best achieved through a mandatory/hard waiver insurance program that mitigates the effect of adverse selection.

Policy Statement General Requirements

All full-time students are required to carry health insurance and will be assessed a charge for the individual basic mandatory plan offered through the university student health insurance program. The charge will appear on the invoice of the first semester of attendance in the academic cycle. The student is required to take one of the following three actions:

1. Enroll in the basic plan as charged.
2. Upgrade the benefit plan by enrolling in the enhanced student health insurance options during the open enrollment period.
3. Apply for a waiver from the mandatory plan.

Requirements for Waiver

Application for a waiver from the university student health insurance plan must be made to Student Health Services by the last day of the open enrollment period. Students applying for waiver must provide documentation of continuing coverage verifying that they are enrolled as the dependent, partner/spouse or principal in an employer or government-sponsored insurance plan. Additionally, the plan must meet minimum standards for coverage as set forth below:

- It must offer at least 75% coverage for inpatient and outpatient medical services in the Pittsburgh area.
- It must include mental health benefits.
- The deductible must not exceed \$500 per accident or illness.
- It must offer medical benefits of at least \$50,000 per accident or illness.
- It must cover pre-existing conditions.

Contact

Questions should be directed to Student Health Services, x8-2157.

Carnegie Mellon Freedom of Expression Policy

Freedom of Expression Policy

Carnegie Mellon University values the freedoms of speech, thought, expression and assembly – in themselves and as part of our core educational and intellectual mission. If individuals are to cherish freedom, they must experience it. The very concept of freedom assumes that people usually choose wisely from a range of available ideas and that the range and implications of ideas cannot be fully understood unless we hold vital our rights to know, to express, and to choose. The university must be a place where all ideas may be expressed freely and where no alternative is withheld from consideration. The only limits on these freedoms are those dictated by law and those necessary to protect the rights of other members of the University community and to ensure the normal functioning of the University.

Rights

On Carnegie Mellon's Campus, anyone may distribute printed material, offer petitions for signature, make speeches, and hold protests or demonstrations outside university buildings. All such activities must be peaceful, avoiding acts or credible threats of violence and preserving the normal operation of the university. No event shall infringe upon the rights or privileges of anyone not in sympathy with it, and no one will be permitted to harm others, damage or deface property, block access to university buildings or disrupt classes. The enforcement of these conditions will not depend in any way on the message or sponsorship of the act or event. When guests are invited by a recognized campus organization, they may express their ideas not because they have a right to do so, but because members of the campus community have a right to hear, see, and experience diverse intellectual and creative inquiry. Devoting that right is a fundamental obligation of the university. Controversy cannot be permitted to abridge the freedoms of speech, thought, expression or assembly. They are not matters of convenience, but of necessity.

Responsibilities

Freedom of expression must be at once fiercely guarded and genuinely embraced. Those who exercise it serve the Carnegie Mellon community by accepting the responsibilities attendant to free expression. University organizations that sponsor invited guests to campus are expected to uphold Carnegie Mellon's educational mission by planning carefully to create safe and thoughtful experiences for those involved. Hosts are responsible for the behavior of their guests and should exercise due care to ensure that all participants abide by relevant university policies.

Considerations for Planning Campus Events

Consistent with the rights and responsibilities outlined in the university's policy on Freedom of Expression, university hosts must follow all applicable policies related to space reservation, use, safety and security, keeping in mind the responsibility to have campus police present for any event with 100 or more persons in attendance.

Hosts should consider the items below as guidance in planning campus events, recognizing that not all of the items will apply to all events:

1. A public declaration of the event, its purpose, the identification of sponsors and co-sponsors, and contact information for those seeking further information.
2. A plan for advertising the event, including advance notice to relevant members of the community who may wish to co-sponsor, protest, or host other events in response to the planned activity.
3. Where appropriate, a clear and detailed contract with outside speakers, artists, or suppliers of services to ensure continuity of purpose and the ability of the host to control the event reasonably, consistent with the host's intent.
4. A plan for access to the event, including notifying the community of reserved seats, ticketing, queuing protocol, or other relevant details or restrictions well in advance of the activity.
5. A provision for security before, during, and after events, managed in coordination with the University Police. Specifically, non-university security personnel must have their allowable duties clearly delineated, in partnership with the University Police, with their role generally limited to personal security and not to space management.
6. A plan for participant engagement at the event, such as through a question and answer session, if relevant, with a clear delineation of the planned ground rules for the event set out well in advance.
7. A strategy for hosting of additional events, discussions, or town meetings before or after a principal event to help provide

a context in which the principal event may be best experienced.

The Office of Student Activities and the Office of the Dean of Student Affairs may assist in, or directly coordinate, some aspects of campus events, such as fostering discussions preceding or following an event, or accommodating an opposing view at an alternative event. It is assumed that the spirit of community, both among people with groups with opposing views, as well as between event sponsors and the Student Activities and Student Affairs staffs, will foster communication and cooperation in the planning of campus events. Wherever possible, Student Affairs will work in concert with University Police to notify occupants of buildings in advance of any potential disruption caused by such events.

Security Personnel Statement

At times, members of the campus community or their invited guests may have a legitimate basis for being accompanied by independent security personnel. It is incumbent upon the host of such an individual to ensure that University Police approve in advance the presence and scope of involvement of any such security personnel.

Human Subjects in Research at Carnegie Mellon University

The university is committed to the protection of the rights and welfare of human subjects in research investigations conducted under the jurisdiction of the university. The university believes that review independent of the investigator is necessary to safeguard the rights and welfare of human subjects of research investigations. All research involving human subjects is conducted in accordance with federal regulations, including Title 45 of the Code of Federal Regulations, Part 46 (45 CFR 46). Under federal regulations, human subjects are defined as: living individual(s) about whom an investigator conducting research obtains:

- (1) data through intervention or interaction with the individual, or
- (2) identifiable private information.

An Institutional Review Board (IRB) is established under the provost to ensure adequate safeguards. The provost is responsible for the composition of the IRB with respect to: (1) the qualifications of IRB members in terms of educational background and research or other relevant experience, and (2) broad representation of relevant university interests.

This IRB is responsible for reviewing investigational procedures involving human subjects prior to the initiation of the research procedure in reference to (1) the rights and welfare of the individuals involved, (2) the appropriateness of the methods used to obtain informed consent, and (3) the risks and potential benefits of the investigations. The IRB is responsible for determining when additional expertise is required for adequate review and for obtaining that additional expertise. The IRB is further responsible for maintaining records of its review activities and decisions and for ensuring that records of informed consent are developed and kept by investigators where appropriate.

It is the responsibility of investigators who plan to use human subjects in research to obtain written consent from the IRB prior to conducting an investigation involving human subjects. It is the investigator's further responsibility to take whatever steps are determined necessary for the protection of the subjects, and to meet the reporting requirements established by the IRB.

Student Immunization Policy

Reason for Policy

Vaccine-preventable diseases continue to occur on American campuses and pose a significant threat to the public health of the campus community. Outbreaks not only impose a significant cost to infected individuals in terms of mortality and morbidity but also can be costly to the university by disrupting university activities.

Policy Statement

The goal of the Student Health Services and the university is to provide adequate protection of the campus community against vaccine-preventable diseases by requiring students to be vaccinated against and/or screened for certain highly contagious diseases. This goal can best be achieved through a mandatory prematriculation immunization requirement. The following requirements are consistent with Pennsylvania State Law and with the recommendations of the American College Health Association, the Advisory Committee on Immunization Practices.

Requirements for All Full-Time Students

- All entering full-time students born after 1956 must demonstrate proof of immunity against measles, mumps and rubella by either providing dates of inoculation of two doses of the measles vaccine and at least one dose of mumps and

rubella or providing blood titers that demonstrate immunity to these infections or providing documentation from a physician of having had the infection.

Additional Requirements for Students Residing in University Housing

- All students residing in university housing must demonstrate immunity against Hepatitis B by either providing documentation of having initiated or completed the three dose vaccination series.
- The student is expected to complete the series within six months of initiation of the series.
- All students residing in university housing must provide documentation of having been vaccinated against meningococcal meningitis within three years prior to enrollment in the university.
- All full-time international students must provide documentation of having had a PPD skin test to screen for tuberculosis within one year prior to enrollment in the university regardless of prior BCG inoculation. If the results of the skin test are positive, a chest x-ray is required.

Request for Waiver

- A student may request a waiver from any vaccination for medical reasons or if vaccination conflicts with personal or religious beliefs. Application for waiver is to be made in writing to Student Health Services prior to the first day of classes in his/her first semester of attendance at the university. In the case of an outbreak of a contagious disease on campus for which the student has not been immunized, the university reserves the right to ask the student to leave campus until the outbreak is over.
- A student may request a waiver from tuberculin skin testing if the student is from a country that has been identified by the Centers for Disease Control as having low prevalence of tuberculosis.

Penalty for Noncompliance

- If the student fails to comply with the immunization policy, the Student Health Services will notify Enrollment Services who will place a hold on the student's registration until the requirements are met and assess a fee of no more than \$50 to the student's account.
- Additionally, if the student is a resident in university housing and fails to comply with the immunization requirements, he/she will be removed from housing.

Contact

Questions should be directed to Student Health Services, x8-2157.

Related Policies and Procedures

The university complies with OSHA regulations regarding occupational exposure to blood-borne pathogens. Questions regarding these regulations should be directed to Environmental Health & Safety, x8-8182.

Additional recommendations

A PPD skin test for tuberculosis is recommended for domestic students who have traveled to an area where tuberculosis is endemic. All students should have a booster dose of tetanus/diphtheria every ten years after completion of the primary series.

Intellectual Property Policy

1. Purpose

The policy reflects the following goals:

- To create a university environment that encourages the generation of new knowledge by faculty, staff, and students.
- To facilitate wide transfer of useful inventions and writings to society.
- To motivate the development and dissemination of intellectual property by providing appropriate financial rewards to creators and the university, and administrative assistance to creators.
- To ensure that the financial return from the development of intellectual property does not distort decisions and operations of the university in a manner contrary to the mission of the university.

The policy is based upon the following principles relating the university to society:

- The mission of the university remains the generation and dissemination of knowledge.
- Intellectual property will be generated within the university, and there exists an obligation to disseminate it. An interface is needed if better technology transfer is to be achieved, and the university will provide mechanisms for that function.[1]

The policy is based upon the following principles relating faculty, staff and students to the university.

- Intellectual property is created by individuals, or by groups of individuals, who are entitled to choose the course of disclosure; academic freedom of individuals is a higher priority than possible financial rewards.
- There exists a historical tradition allowing authors to retain ownership of intellectual property rights from textbooks and works of art.
- The university is the support of the whole campus community, and is thereby entitled to share in financial rewards.
- There should be incentives for all parties to pursue financial rewards together, consistent with the expressed goals of the policy. The distribution of these rewards should reflect, insofar as possible, the creative contributions of the creator, and the resources contributed by and risks assumed by both the creator and the university in developing intellectual property.
- Since it is frequently difficult to assess risks meaningfully, resources and potential rewards, negotiated agreements are to be encouraged whenever possible.

2. Definitions

Certain terms are used in this document with specific meanings, as defined in this section. These definitions do not necessarily conform to customary usage.

Intellectual Property includes any patentable invention, any copy-rightable subject matter, or trade secret. It also includes works of art, and inventions or creations that might normally be developed on a proprietary basis.

University means Carnegie Mellon.

Student means any full-time or part-time graduate or undergraduate student, regardless of whether the student receives financial aid from the university or from outside sources. It is the responsibility of students who are also employees of other outside entities to resolve any conflicts between this policy and provisions of agreements with their employers prior to beginning any undertaking at the university that will involve the development of intellectual property.

Faculty means members of the university's Faculty Organization as defined in the Faculty Handbook, plus instructors and special faculty appointments (even in the first year), and part-time faculty.

Staff means any employee of the university other than students and faculty as defined above. If a student is also a part-time university employee, he is considered as staff with regard to intellectual property developed as a result of his employment, and as a student with regard to other intellectual property. A full-time non-faculty employee who is also taking one or more courses is considered to be staff. Visitors to the university who make substantial use of university resources are considered as staff with respect to any intellectual property arising from such use. (The distinction between faculty and staff does not affect intellectual property rights except for representation on the Intellectual Property Adjudication Committee [see Section 5].)

Creator means any person or persons who create an item of intellectual property.

Net proceeds to the university means all proceeds received by the university on intellectual property that it assigns, sells or licenses, minus any application, litigation, interference, or marketing costs directly attributable to the intellectual property being licensed. Deducted costs shall be reasonable and fair, and shall be properly disclosed; the sources and amounts of compensation shall also be properly disclosed.

Net proceeds to the creator means all proceeds received by the creator from intellectual property owned by him that he sells, assigns or licenses, less the costs of application, legal protection, or litigation, interference, travel and other marketing costs directly attributable to the intellectual property being exploited. Such net proceeds do not include compensation legitimately received by the creator for consulting services or interest or other return on

invested labor or capital. Deducted costs shall be reasonable and fair, and shall be properly disclosed; the sources and amounts of compensation shall also be properly disclosed.

Substantial use of university facilities means extensive unreimbursed use of major university laboratory, studio or computational facilities, or human resources. The use of these facilities must be important to the creation of the intellectual property; merely incidental use of a facility does not constitute substantial use, nor does extensive use of a facility commonly available to all faculty or professional staff (such as libraries and offices), nor does extensive use of a specialized facility for routine tasks. Use will be considered "extensive" and facilities will be considered "major" if similar use of similar facilities would cost the creator more than \$5000 (five thousand dollars) in constant 1984 dollars if purchased or leased in the public market. Creators wishing to directly reimburse the university for the use of its facilities must make arrangements to do so before the level of facilities usage for a particular intellectual property becomes substantial. (This provision is not intended to override any other department or university policy concerning reimbursement for facilities usage.)

In general:

In any given year the equivalent figure for a particular amount of money in constant 1984 dollars will be obtained by multiplying that amount of money by the ratio of the most recent quarterly Disposable Personal Income Deflator divided by the average monthly Disposable Personal Income Deflator for the year 1984.

As used in this policy, the masculine gender includes the feminine gender, singular or plural, wherever appropriate.

3. Policy Provisions

This section states the policies concerning ownership of intellectual property created at the university. In order of precedence, ownership of intellectual property shall be as follows:

3-1. Externally Sponsored Work

Ownership Provisions: Intellectual property created as a result of work conducted under an agreement between an external sponsor and the university that specifies the ownership of such intellectual property shall be owned as specified in said agreement. If the university declares itself to be a sponsor, but does not declare itself to be the owner of the intellectual property, ownership shall be determined in accordance with 3-6-4 below.

Procedural Provisions: It is the responsibility of the Office of Sponsored Research of the university to inform each person whose intellectual property rights are limited by an externally sponsored contract of the intellectual property provisions of that contract in advance of the beginning of work thereon. Such notice is to be in writing and the university may require written acknowledgment of such provisions by any person working on externally sponsored projects. A summary of external sponsorship agreements limiting the intellectual property rights of potential creators will be maintained by the Office of Sponsored Research and will be available to the general university community.

If the university fails to notify a creator, effectively and in advance, of limitations imposed on his intellectual property rights by external sponsorship agreements, the creator is entitled to receive from the university 50% (fifty percent) of the net proceeds to the university resulting from his intellectual property.

3-2. Internally Sponsored Work

Ownership Provisions: When the university provides funds or facilities for a particular project to the extent of substantial use, it may also choose to designate itself as sponsor of that work. The university may declare itself the owner of intellectual property resulting from said work. In such cases the university must specify in advance the disposition of any intellectual property rights arising from the project. If the university declares itself to be a sponsor, but does not declare itself the owner of the intellectual property, ownership shall be determined in accordance with 3-6-4 below.

Procedural Provisions: It is the responsibility of the Office of Sponsored Research of the university to inform each person whose intellectual property rights are limited by internally sponsored work of the intellectual property ownership rights specified by the university as to that work in advance of the beginning of work thereon. Such notice is to be in writing and the university may require written acknowledgment of such provisions by any person working on internally sponsored projects. A summary of work for which university sponsorship limits the intellectual property rights of potential creators will be maintained by the Office of Sponsored Research and will be available to the general university community.

If the university fails to notify a creator, effectively and in advance,

of limitations imposed on his intellectual property rights by internal university sponsorship, the creator is entitled to receive from the university 50% (fifty percent) of the net proceeds to the university resulting from his intellectual property.

3-3. Individual Agreements

Ownership Provisions: Intellectual property which is the subject of a specific agreement between the university and the creator(s) thereof shall be owned as provided in said agreement. Such agreements by the university and the faculty are encouraged.

Procedural Provisions: Except where limited by external sponsorship agreements, creators and the university may negotiate individual agreements to govern ownership of intellectual property regardless of the applicability of any other provision hereof.

3-4. Intellectual Property Created Within Scope of Employment

Ownership Provisions: Intellectual property created by university employees who were employed specifically to produce a particular intellectual property shall be owned by the university if said intellectual property was created within the normal scope of their employment. Faculty are presumed not to be hired to produce a particular intellectual property. On the other hand, computer programs written on the job by staff computer programmers would fall under this provision.

3-5. Public Dedication

Ownership Provisions: Except when limited by subparts 3-1, 3-2, 3-3 or 3-4 above, the creator of any intellectual property may choose to place his or her creation in the public domain. In such cases both the creator and the university waive all ownership rights to said property.

Procedural Provisions: Creators wishing to place their intellectual property in the public domain are responsible for ascertaining that the right to public dedication of that intellectual property is not limited by any external agreement, university sponsorship arrangement or terms of employment as described in Provisions 3-1, 3-2 or 3-3. The university provost will provide such a determination in writing upon request by the creator. It is also the creator's responsibility to ensure that disclosure does not include valuable intellectual property owned by others. (This provision does not release the university from its general obligation to notify creators of limitations to intellectual property rights specified in Provisions 3-1 and 3-2.)

To facilitate the actual transfer of knowledge of the intellectual property to the public at large, the creator shall provide the university with a complete description and documentation of the property placed in the public domain, specifically including a copy of the property in the case of printed material, and complete machine-readable source code in the case of software. All such material provided to the university will be placed in the University Library and made available to the public at large. The university will take appropriate action on a regular basis to publicize summary descriptions of intellectual property recently placed in the public domain. The university will also provide any member of the general public copies of such material on a cost-recovery basis.

The provisions of this section do not apply to the normal scholarly or creative publication processes unless the creator intends to waive all proprietary rights to the publication.

3-6. In General

Unless governed by subparts 3-1, 3-2, 3-3, 3-4 or 3-5 above, ownership of intellectual property created at the university shall be determined as follows:

3-6-1. Traditional Rights Retained

Ownership Provisions: In keeping with academic traditions at the university, the creator retains all rights to the following types of intellectual property, without limitation: books (including textbooks), educational courseware, articles, non-fiction, novels, poems, musical works, dramatic works including any accompanying music, pantomimes and choreographic works, pictorial, graphic and sculptural works, motion pictures and other similar audio-visual works, and sound recordings, regardless of the level of use of university facilities. This provision does not include computer software (other than educational courseware) or data bases.

Procedural Provisions: The types of intellectual property listed in the preceding paragraph share the attribute that they display information or visual or auditory appearances which are fully revealed to the purchaser or consumer. Thus, for example, source code listings would also be considered within this category. On the other hand, most computer software and data bases do not

share this attribute; they are characterized by their capacity to perform tasks. Because of their utilitarian nature, ownership rights with respect thereto are governed by 3-6-3 or 3-6-4. Educational courseware is included in this provision in all cases because of its role in furthering the primary educational mission of the university.

This provision applies regardless of any university sponsorship of the work, and it may be modified only by a specific prior agreement between the creator and the university. The use of university-owned computers and other facilities in the preparation of books and similar works does not alter this provision, though other university policies may limit such use or require reimbursement to the university. Similarly, the use of externally sponsored resources does not alter this provision, unless the creator is effectively notified in advance of such limitations to his rights in accordance with 3-1.

3-6-2. No Substantial Use of University

Facilities Ownership Provisions: The creator owns all intellectual property created without substantial use of university facilities, including intellectual property rights in computer software and data bases.

3-6-3. Substantial Use of University Facilities - No External or Internal Sponsorship

Ownership of intellectual property created with substantial use of university facilities, but not directly arising from externally sponsored work, or from work for which the university has declared itself as sponsor, shall be determined as set forth hereinafter depending on whether the creator or the university develops said property.

3-6-3-1. Development by Creator

Ownership Provisions: The creator originally owns intellectual property created with substantial use of university facilities but no external or internal sponsorship, and retains said ownership by commercial development of said property subject to the following:

(i) the university shall receive 15% (fifteen percent) of the net proceeds to the creator above \$25,000 (twenty-five thousand dollars) in constant 1984 dollars from all sources (in the case of patents and copyrights, this provision shall be limited to the life of the patent or copyright), and

(ii) the university shall receive a perpetual, non-exclusive, non-transferrable, royalty free license to use said intellectual property. In the case of software, this license includes access by specified university personnel to the source listings, and the university shall require each person to whom a disclosure is made to execute in advance a binding confidentiality agreement in favor of and enforceable by the creator. If the intellectual property is created solely by a student or students, the creator is exempt from the obligation to pay to the university a fraction of his net proceeds, but not from the provision of this paragraph for a non-exclusive license to the university.

Procedural Provisions: If the creator develops an intellectual property that is covered by this provision, he must make full and fair disclosure to the university of all such sources of compensation relating to that intellectual property.

3-6-3-2. Development by the University

Ownership Provisions: When intellectual property is created with substantial use of university facilities, but not directly arising from sponsored research, the creator will originally retain the rights to the property, provided that he desires to commercially develop the property himself or to make it available to the public. If, however, the creator elects not to commercially develop same or fails to show diligence in pursuing such development, then the ownership rights to that property may be acquired by the university. Intellectual property acquired by the university in this fashion will be treated as in 3-6-4-1 below.

Procedural Provisions: At the time the intellectual property is disclosed to the university's provost as required under Section 4-1, or at any time thereafter, the university may request that the creator decide whether he will develop the intellectual property or will grant the rights to the university, and execute documents to pass on the title. Such a decision must be made within one year of the request or the creator will automatically lose his rights in favor of the university.

3-6-4. Substantial Use of University Facilities - External or Internal Sponsorship

Ownership of intellectual property created with substantial use of university facilities and directly arising from work sponsored under an agreement between an external sponsor and the university, or from work for which the university has declared itself a sponsor, but for which neither the external sponsor nor the university have

specified the ownership of resulting intellectual property shall be determined as set forth hereinafter depending on whether the creator or the university develops said property.

3-6-4-1. Development by University

Ownership Provisions: The university originally owns intellectual property created with substantial use of university facilities provided by an external agreement or internal university sponsorship and retains said ownership by commercial development of said property, subject to the following: in all cases, the creator shall receive 50% (fifty percent) of the net proceeds to the university.

Procedural Provisions: When an intellectual property is created with substantial use of university resources provided by an external research contract or a specific university sponsorship agreement, and when that contract or agreement either does not specify the disposition of the intellectual property rights arising from that sponsorship, or it permits the university and/or creator to retain or acquire such intellectual property rights, the university will originally retain the rights to such intellectual property.

3-6-4-2. Development by Creator

Ownership Provisions: When intellectual property is created with substantial use of university facilities provided by external or internal sponsorship, the university will originally retain the rights to the property, provided that it desires to commercially develop the property or to make it available to the public. If, however, the university elects not to commercially develop same or fails to show diligence in such development, the ownership rights to that property may be acquired by the creator. Intellectual property acquired by the creator in this fashion will be treated as in 3-6-3-1 above. This assignment of rights to the creator may be prohibited by the terms of an external sponsorship agreement with the university or by an internal university sponsorship declaration, but in such cases the creator must be notified in advance, as in Provisions 3-1 and 3-2.

Procedural Provisions: At the time the intellectual property is disclosed to the university's provost as required by Section 4-1, or at any time thereafter, the creator may request that the university decide whether it will commercially develop the intellectual property or execute an assignment of the intellectual property rights to the creator. Such a decision must be made within 120 (one hundred twenty) days of the request or the university automatically waives its rights in favor of the creator, and it must execute an assignment of these rights to the creator.

3-6-5. Consulting Agreements

Ownership Provisions: Work done by individuals as consultants to outside firms is presumed not to involve unreimbursed substantial use of university facilities, and the rights to intellectual property created under consulting agreements are retained by the outside firms or the individual as specified by the terms of the consulting agreement and the terms of Provision 3-6-2 above.

Procedural Provisions: Under university policy consulting work must not make substantial unreimbursed use of university facilities except by explicit prior agreement. Any member of the university community who is engaged in consulting work or in business is responsible for ensuring that provisions in his agreements are not in conflict with this policy of the university or with the university's commitments. The university's Innovation Transfer Office will, upon request, provide assistance in this respect. The university's rights and the individual's obligations to the university are in no way abrogated or limited by the terms of such agreements. Each creator of intellectual property should make his obligations to the university clear to those with whom he makes such agreements and should ensure that they are provided with a current statement of the university's intellectual property policy. Appropriate sample contract wording to cover various possible external consulting arrangements shall be available from the university provost.

4. General Procedures 4-1.

The creator of any intellectual property that is or might be owned by the university under this policy is required to make reasonably prompt written disclosure of the work to the university's provost, and to execute any document deemed necessary to perfect legal rights in the university and enable the university to file patent applications and applications for copyright registration when appropriate. This disclosure to the provost should be made at the time when legal protection for the creation is contemplated, and it must be made before the intellectual property is sold, used for profit, or disclosed to the public. Whenever legal protection for intellectual property is anticipated all persons engaged in such creative activity are encouraged to keep regular notebooks and records.

4-2.

Whenever the university undertakes commercial development it shall do so, if possible, in a fashion that provides for the widest possible dissemination, avoiding suppression of inventions from which the public might otherwise benefit, providing for non-exclusive licensing at reasonable royalties, and giving consideration to more favorable or royalty-free licensing to non-profit charitable institutions, minority businesses or enterprises in developing countries.

4-3.

The university's share of any proceeds under this policy will be used to reimburse the university for its expenses for commercial development of intellectual property. Any additional return to the university will be used to further the academic purposes of all the disciplines of the entire university.

5. Resolution of Disputes

This policy constitutes an understanding which is binding on the university and on the faculty, staff, and students upon whom it is effective according to the terms of Section 6 below, as a condition for participating in research programs at the university or for the use of university funds or facilities.

Any question of interpretation or claim arising out of or relating to this policy, or dispute as to ownership rights of intellectual property under this policy, will be settled by the following procedure:

1. The issue must first be submitted to the university's Intellectual Property Adjudication Committee in the form of a letter setting forth the grievance or issue to be resolved. The committee will review the matter and then advise the parties of its decision within 60 days of submission of the letter.
2. If any of the parties to the dispute is not satisfied with the committee's decision, the party may seek binding arbitration in Pittsburgh, Pennsylvania and in accordance with the Rules of the American Arbitration Association then in effect. Judgment upon the award rendered by the arbitrator(s) may be entered in any court having jurisdiction thereof. The arbitrator(s) will give some weight to the decision of the Intellectual Property Adjudication Committee in reaching a decision. The losing party of the arbitration hearing will pay for all costs of the arbitration unless the arbitrator(s) specifies otherwise.

The Intellectual Property Adjudication Committee will consist of a chair who is a member of the tenured faculty, four other members of the faculty, and four other members representing, respectively, the university administration, the technical staff, and the graduate and undergraduate student bodies. Initially, half of the members of the committee (including the chair) will be appointed for two-year terms of office, and the remaining half will be appointed for a one-year term. After one year new members of the committee will be appointed for two-year terms of office. The chair will be appointed by the chair of the Faculty Senate, with the advice and consent of the Faculty Senate Executive Committee, and the remaining eight members of the committee will be appointed by the president of the university or his designee. At all times at least one of the faculty members will have had significant practical experience with intellectual property development and exploitation. The faculty members appointed by the president of the university will be selected from a list of nominees prepared by the Faculty Senate or its designated committee and nominees with experience in intellectual property development will be identified as such by the Faculty Senate. The staff representative will be selected from a list of nominees prepared by Staff Council, and the administration representative will be named directly by the president of the university or his designee. The graduate student representative will be selected from a list of nominees prepared by the Graduate Student Organization. The undergraduate representative will be chosen from a list of nominees prepared by the Student Senate. The committee will use the guidelines set forth in this policy to decide upon a fair resolution of any dispute.

If possible, the committee will also provide on request informal advisory opinions to creators and the university indicating how it is likely to interpret the provisions of this policy as it applies to special cases.

6. Effective Date of Policy

This policy will become effective August 27, 1985. Once effective this policy will be binding on new faculty, administration, and staff when hired, and on graduate and undergraduate students when

admitted. Current faculty and staff will also become bound by this policy when they sign new employment contracts as the result of the renewal of limited-term appointments or promotion. Other university personnel, including tenured faculty, and current staff and students may choose to become bound by this policy for future and pending intellectual property by voluntary written consent. Unless the creator and the university agree to a different arrangement, intellectual property that is already partially developed at the time this policy becomes effective will be treated according to the provisions of the patent policy by which the University creator is currently bound. Similarly, members of the university working under contracts signed before the effective date of this policy who do not choose to accept this policy will remain bound by the patent policies that already apply to them. With respect to intellectual property developed during the course of employment at the university, this policy shall continue to be binding on any person whose relationship with the university becomes terminated. The university should take all administrative steps necessary to ensure that employees and students sign, upon initial employment, registration or at other appropriate times, forms that indicate their acceptance of this policy.

7. Amendments of the Policy

Amendments of this policy may be proposed by the Faculty Senate, Staff Council or university administration. Proposed amendments must be approved by a two-thirds majority of votes in the Faculty Senate and subsequently approved by a simple majority of votes cast in a referendum administered by the Faculty Senate that is open to all members of the faculty as defined by this policy and to the exempt staff, provided that this majority constitutes at least 25% (twenty-five percent) of those eligible to vote. This referendum must be preceded by an opportunity for public discussion open to all interested faculty, administration, staff and students. Amendments that are supported by the faculty and staff must then be approved by the president of the university and adopted by the university trustees. Once adopted, amendments will become binding on new faculty, administration, and staff when hired, on existing faculty and staff when they sign new employment contracts, and on graduate and undergraduate students when admitted. Other university personnel, including tenured faculty, and current staff and students may choose to become bound by this policy for future and pending intellectual property by voluntary written consent. Intellectual property that is already developed or under development at the time that an amendment to the policy is ratified will not be bound by the terms of the amendment without the voluntary written consent of both the creator and the university.

Footnote:

1. This document presumes the existence of a university office to facilitate technology transfer. Such an office would serve as a clearinghouse for contacts with outside partners, would perform patent and copyright tasks, and would develop an effective marketing capability.

Policy on Student Privacy Rights

Policy Statement

Under the Family Educational Rights and Privacy Act (FERPA), you have the right to:

- Inspect and review your education records;
- Request an amendment to your education records if you believe they are inaccurate or misleading;
- Request a hearing if your request for an amendment is not resolved to your satisfaction;
- Consent to disclosure of personally identifiable information from your education records, except to the extent that FERPA authorizes disclosure without your consent;
- File a complaint with the U.S. Department of Education Family Policy Compliance Office if you believe your rights under FERPA have been violated.

1. Inspection

What are education records?

Education records are records maintained by the university that are directly related to students. These include biographic and demographic data, application materials, course schedules, grades and work-study records. The term does not include:

- Information contained in the private files of instructors and administrators, used only as a personal memory aid and not accessible or revealed to any other person except a temporary substitute for the maker of the record;

- Campus Police records;
- Employment records other than work-study records;
- Medical and psychological records used solely for treatment purposes;
- Records that only contain information about individuals after they have left the university;
- Any other records that do not meet the above definition of education records.

How do I inspect my education records?

- Complete an Education Inspection and Review Request Form (available online as a PDF document or from The HUB, 12C Warner Hall) and return it to The HUB.
- The custodian of the education record you wish to inspect will contact you to arrange a mutually convenient time for inspection, not more than 45 days after your request. The custodian or designee will be present during your inspection.
- You will not be permitted to review financial information, including your parents' financial information; or confidential letters of recommendation, if you have waived your right to inspect such letters.
- You can get copies of your education records from the office where they are kept for 25 cents per page, prepaid.

2. Amendment

How do I amend my educational records?

- Send a written, signed request for amendment to the Vice President for Enrollment, Carnegie Mellon University, 610 Warner Hall, Pittsburgh, PA 15213. Your request should specify the record you want to have amended and the reason for amendment.
- The university will reply to you no later than 45 days after your request. If the university does not agree to amend the record, you have a right to a hearing on the issue.

3. Hearing

How do I request a hearing?

- Send a written, signed request for a hearing to the Vice President of Campus Affairs, Carnegie Mellon University, 610 Warner Hall, Pittsburgh, PA 15213. The university will schedule a hearing no later than 45 days after your request.

How will the hearing be conducted?

- A university officer appointed by the Vice President of Campus Affairs, who is not affiliated with your enrolled college will conduct the hearing.
- You can bring others, including an attorney, to the hearing to assist or represent you. If your attorney will be present, you must notify the university ten days in advance of the hearing so that the university can arrange to have an attorney present too, if desired.
- The university will inform you of its decision, in writing, including a summary of the evidence presented and the reasons for its decision, no later than 45 days after the hearing.
- If the university decides not to amend the record, you have a right to add a statement to the record that explains your side of the story.

4. Disclosure

Carnegie Mellon generally will not disclose personally identifiable information from your education records without your consent except for directory information and other exceptions specified by law.

What is directory information?

Directory information is personally identifiable information of a general nature that may be disclosed without your consent, unless you specifically request the university not to do so. It is used for purposes like compiling campus directories.

If you do not want your directory information to be disclosed, you must notify The HUB, 12C Warner Hall, in writing within the first 15 days of the semester.

Notifying The HUB covers only the disclosure of centralized records. Members of individual organizations such as fraternities, sororities, athletics, etc. must also notify those organizations to restrict the disclosure of directory information.

Carnegie Mellon has defined directory information as the following:

- your full name,
- local/campus address,
- local/campus telephone number,
- email user id and address,

(User ids cannot be completely suppressed from our electronic systems. While it may be possible to suppress the association of an individual's name with their user id, doing so may adversely impact the delivery of electronic mail or other electronic services.)

- major, department, college,
- class status (freshman, sophomore, junior, senior, undergraduate or graduate)
- dates of attendance (semester begin and end dates),
- enrollment status (full, half, or part time)
- date(s) of graduation,
- degrees awarded,
- sorority or fraternity affiliation.

For students participating in intercollegiate athletics, directory information also includes:

- height, weight,
- sport of participation.

What are the other exceptions?

Under FERPA, Carnegie Mellon may release personally identifiable information from your education records without your prior consent to:

- school officials with legitimate educational interests ("School officials" are Carnegie Mellon employees in administrative, supervisory, academic or support staff positions; Carnegie Mellon trustees; individuals and companies with whom the university has contracted, such as attorneys, auditors, or collection agencies; and individuals assisting school officials in performing their tasks. School officials have a "legitimate educational interest" if they need to review an education record in order to fulfill their professional responsibilities.);
- certain federal officials in connection with federal program requirements;
- organizations involved in awarding financial aid;
- state and local officials who are legally entitled to the information;
- testing agencies such as the Educational Testing Service, for the purpose of developing, validating, researching and administering tests;
- accrediting agencies, in connection with their accrediting functions;
- parents of dependent students (as defined in section 152 of the Internal Revenue Service Code);
- comply with a judicial order or subpoena (after making a reasonable effort to notify the student in advance of compliance so that the student can take protective action, except in cases where the university is legally required not to disclose the existence of the subpoena);
- appropriate parties in a health or safety emergency, if necessary to protect the health or safety of the student or other individuals;
- officials of another school in which the student seeks or intends to enroll;

- victims of violent crimes or non-forcible sexual offenses (the results of final student disciplinary proceedings);
- parents or legal guardians of students under 21 years of age (information regarding violations of university drug and alcohol policies);
- courts (records relevant to legal actions initiated by students, parents or the university).

5. Complaints

If you believe the university has not complied with FERPA, you can file a complaint with the:

Family Policy Compliance Office, Department of Education, 400 Maryland Avenue, S.W. Washington, DC 20202-4605

Policy on Restricted Research

Universities have two primary purposes: to create knowledge and to disseminate knowledge. Carnegie Mellon University recognizes the importance of open intellectual communication within a research group, within the university, and within the larger community outside. Ideally, all units of the university would disseminate the results of research as quickly and as widely as possible. Some members or units of the university, however, desire to do research that may be difficult or impossible without restrictions or without access to classified or proprietary materials.

There exists, therefore, a tension between the university's goal of disseminating knowledge freely and the desire on the part of some of its members to conduct restricted research on important problems. The university intends to guarantee the academic freedom of all faculty members to do research in their own manner on topics of their own choosing, provided that such research is consistent with the overall purposes of the university.

This policy seeks to resolve the tension between the desire to participate in restricted research and the desire to maintain the open atmosphere of the university by confining restricted research to semi-autonomous units, which are not associated with any academic departments. It thereby establishes the principle that restricted research is inappropriate at Carnegie Mellon University except in the semi-autonomous units.

This policy does not attempt to anticipate all possible concerns about restricted research. In some cases, decisions will need to be made about particular research projects to which the application of particular policy guidelines are not clear. In choosing to accept or decline such projects, the university will weigh the potential of a project for generating and disseminating new knowledge for the benefit of society, against the project's potential for adversely affecting the climate for research conducted in a free and open environment. While this policy sets no explicit limits on the extent of classified research permitted in the semi-autonomous units, it is not the intent of the policy to encourage any unit of the university to engage in classified research as a primary ongoing activity. Indeed, it is expected that classified projects will never represent more than a small fraction of the total research effort in any unit.

Definitions

Research: all projects and investigations involving the creation of new knowledge of a theoretical or practical nature. The term "research" as used here encompasses both "research" and "development" as they are commonly defined.

Classified research: research, the free dissemination of the results of which is deemed to jeopardize national security. The federal government controls access to the environment in which such research is performed, restricts discussions about the work in progress to individuals with clearance and a "need to know," and limits publication of research, results or access to data needed to verify results, for a specified period of time.

Proprietary research: research that results in intellectual property that is owned by entities other than Carnegie Mellon University. Such entities may wish to market products derived from inventions or ideas that are developed at the university. They might, therefore, desire to fund projects which restrict access to data and to discussions about work in progress to individuals with a "need to know," and to seek, for a specified period of time, a delay in

publication of research results or data needed to verify results. Such entities may also provide access to proprietary material, which researchers must agree not to include in publications.

Publication: oral or written dissemination.

Restricted research: includes all classified research, and any proprietary or other research that requires more than a six month delay in publication of the research results.

Semi-autonomous units: units of the university specifically so designated by the president, after consultation with the URC and the Faculty Senate, currently the Mellon Institute and the Software Engineering Institute.

Non-autonomous units: all university entities other than semi-autonomous units.

Restricted Research in Non-Autonomous Units

It is the policy of Carnegie Mellon that restricted research is inappropriate and, therefore, not permitted within its non-autonomous units.

It is also the policy of Carnegie Mellon not to permit involvement of students in projects which carry restrictions that may impede their progress toward a degree. Therefore, students should not be involved in contracts that require the delay of a student's publication of research results when such results are intended for use in obtaining academic credit, except that a sponsor may require a delay of thirty days for review of publications for removal of proprietary information that was provided by the sponsor for the conduct of the research.

Proprietary research is allowed within non-autonomous units provided it is subject to limitations (excluding students' publications as noted above) no more stringent than the following:

- A sponsor may request a delay of up to six months in publication so that steps may be taken to secure intellectual property rights to inventions or ideas developed under the contract.
- A sponsor may require a delay of thirty days for review of publications for removal of proprietary information which was provided for the conduct of the research.

Considerations for faculty/researchers:

The university recognizes that problems arise in both restricted research and research that is not itself restricted but that involves access to classified or propriety information or materials (hereinafter, restricted materials). Researchers may also have access to restricted materials when serving as consultants. Access to restricted materials gives rise to concerns about limitations on researchers' freedom to communicate. In such instances, researchers must exercise consider-able judgment to conduct their research in an open environment while protecting the restricted materials to which they have access. Researchers must also be aware that the university will judge their performance as researchers through their publications or through other scholarly products that arise from their research. Research that is restricted in dissemination, or not available for public review, cannot be considered in promotion or reappointment decisions or in evaluations of academic performance of any kind.

Considerations for faculty/researchers:

There are important concerns about the involvement of students in restricted research. It is necessary for students to publish their work in order to obtain degrees, course credit and professional recognition. Students rely to a large degree on their faculty advisor's judgment for guidance and advice. Research that is restricted in dissemination, or not available for public review, cannot be used for academic credit. Thus, before working on such research, a student must be notified in writing that work on this research may not be used for academic credit.

Restricted Research in Semi-Autonomous Units

The semi-autonomous units associated with Carnegie Mellon may conduct restricted research.

Faculty members may conduct restricted research in or in cooperation with semi-autonomous units only on a consulting basis or by means of a formal, internal leave of absence from their non-autonomous units.

Work that is restricted in any way may not be used for academic evaluations until it is released for publication, and then only with respect to future academic actions.

Students may occasionally be employed by the semi-autonomous units, provided that such employment does not interfere substantially with progress toward a degree. However, they must be made aware that work that is restricted cannot be used for academic credit. Work that was restricted and is later released for dissemination and review can be applied toward future academic credit. Students should be discouraged from working on restricted research in which dissemination may be delayed indefinitely.

Guidelines for all Units

Work by students on restricted research projects shall not be made a condition for admission or financial aid.

The principal investigator is responsible for informing all members of a project (faculty, staff and students) of any restrictions imposed on the dissemination of information related to the research. This must be done prior to the start of the project or prior to an individual joining an existing project.

Restrictions on access to university facilities due to the conduct of restricted research must be kept to a minimum. Access to and movement through the facilities in which restricted research is conducted must be consistent with standard university procedures.

The Provost's Office is responsible for obtaining signed documents from principal investigators on restricted research projects attesting that they are aware of all restrictions imposed on the research and that they have informed all participants of these restrictions.

The Office of Sponsored Research shall review all proposals and contracts prior to approval for conformity with these guidelines. Any that do not meet these guidelines will be referred to the University Research Council (URC) for review and recommendation of appropriate action to the provost.

To maintain a balance with the university's goals of broad dissemination of knowledge, the URC will conduct an annual review of all restricted research being conducted at the university. This review will be made based on a listing of all contracts that involve restricted research. This listing shall include the title and sponsor(s) of the research, name(s) of principal investigator(s), and the amount of funding of each contract.

The university community will be informed annually, through the URC's written report to the Faculty Senate and Student Senate, of the nature and overall impact of restricted research at Carnegie Mellon.

Existing sponsored research projects shall be allowed to continue under the terms of their present contract. However, renewal contracts must conform with this policy.

Statement of Assurance

Carnegie Mellon University does not discriminate and Carnegie Mellon University is required not to discriminate in admission, employment, or administration of its programs or activities on the basis of race, color, national origin, sex or handicap in violation of Title VI of the Civil Rights Act of 1964, Title IX of the Educational Amendments of 1972 and Section 504 of the Rehabilitation Act of 1973 or other federal, state, or local laws or executive orders.

In addition, Carnegie Mellon University does not discriminate in admission, employment, or administration of its programs on the basis of religion, creed, ancestry, belief, age, veteran status, sexual orientation or in violation of federal, state, or local laws or executive orders. However, in the judgment of the Carnegie Mellon Human Relations Commission, the Department of Defense policy of "Don't ask, don't tell, don't pursue" excludes openly gay, lesbian and bisexual students from receiving ROTC scholarships or serving

in the military. Nevertheless, all ROTC classes at Carnegie Mellon University are available to all students.

Inquiries concerning application of these statements should be directed to the provost, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, telephone (412) 268-6684 or the vice president for enrollment, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, telephone (412) 268-2056.

Carnegie Mellon University publishes an annual campus security report describing the university's security, alcohol and drug, and sexual assault policies and containing statistics about the number and type of crimes committed on the campus during the preceding three years. You can obtain a copy by contacting the Carnegie Mellon Police Department at 412-268-2323. The security report is also available online.

Student Activities Fee

By action of the Board of Trustees, a required Student Activities Fee in addition to tuition is charged to all under-graduate students and graduate students who enroll for 19 units or more. Student Government is responsible for administering the fee and for using it only for the support of projects under the following guidelines:

1. Activities and facilities which can be described as meeting the reasonably predictable social, cultural, recreational, or welfare needs of college students.
2. Publications which can reasonably be presumed to serve the needs of the student community for communication, expressions of opinion, and the conduct of their business.
3. Such enterprises of an entrepreneurial nature undertaken by the student body as can reasonably be expected to serve as an instrument for meeting the needs described above.

All functions and services provided by the fees described above must be in accordance with Carnegie Mellon's policy of non-discrimination. In addition, no use of such fees may be intended to violate or circumvent the policies of the university or the laws of the land.

Final responsibility for establishing the amount of any required fee rests with the Board of Trustees, which will consider changes only upon requests of the Student Government and the officers of the university.

Note: Historically, the Student Government has dedicated a specific portion of graduate students' activities fees to the Graduate Student Assembly to be used at their discretion.

Policy on Temporary Emergency Closing of the University

Policy Statement

Carnegie Mellon University has an important commitment to students, parents, sponsors, benefactors and the community. Accordingly, the university will make every attempt to operate normally during severe weather or other emergencies. This includes holding classes, conducting research programs, and operating facilities and services. The university will attempt to operate normally unless such operation represents a clear danger to students, staff or faculty.

There may be occasions when the university community is served best by suspending normal operations. In that event, only the president (or the president's designated representative) has the authority to close the university and to specify those persons or group of persons who are free to leave or refrain from coming to campus. Staff members who provide primary services, including certain members of Physical Plant, Dining Services and Security, may be asked to work.

Standard Operations

Unless the president announces that the university is closed, everyone is expected to be at work as usual. When the university is in session, faculty members are expected to meet their scheduled classes and other obligations. If a faculty member is unable to meet a scheduled class, he or she should notify the department office and arrange either for a qualified substitute or for a future make-up session.

If the university is open but a staff member is unable to come to work because of severe weather or other emergency, he or she should notify the supervisor as soon as possible. Staff members will be expected to make up lost time or use Paid Time Off (PTO), consistent with regular operating protocols.

Announcement of Closing

As soon as the president or his/her designee determines that the university must be closed, University Relations will alert local radio and television stations. Also, announcements of closings will be posted on the Carnegie Mellon electronic board official.cmu-news.

Contact

Questions concerning this policy or its intent should be directed to the Office of the President, extension x8-2200.

Student Leave Policy

www.cmu.edu/policies/documents/StLeave.html

Students must sometimes interrupt their studies for a variety of reasons (financial, academic or personal). Students choosing to take a leave of absence should first contact their department advisor to discuss their plans while on leave and to work out any conditions that may be necessary for a smooth return to Carnegie Mellon.

A student may leave Carnegie Mellon by either withdrawing from the university (leaving the university with no intention of returning) or by taking a leave of absence (leaving the university temporarily, with the firm and stated intention of returning).

A Leave of Absence Form must be completed by all students requesting a leave. A Withdrawal Form must be filled out by all students who are withdrawing. Notifying instructors and no longer attending classes does not complete the process. Forms are available in the academic departments, deans' offices and on The HUB website. Not completing the form results in tuition being charged to the midpoint of the semester or the last date the student attended an academically-related activity such as an exam, tutorial or study group, or the last day a student turned in a class assignment.

Students are required to fill out all information on the form, including all comment sections relating to reasons for their leave. After completing the form, students must take it to their home department and dean's office for appropriate signatures. The process of taking a leave will not be complete until all necessary signatures are on the leave form. Under certain circumstances, students may also need the Dean of Student Affairs to sign the appropriate form. Nonresident alien students must consult the Office of International Education for information on possible visa implications prior to going on leave.

Students on leave are not permitted to live in university housing or attend classes or maintain employment as students at Carnegie Mellon while their leave is in effect.

Doctoral candidates under ABD status (All But Dissertation) who wish to take a leave of absence should refer to the ABD and In Absentia policy.

Leaves during the academic semester will take effect as of the date signed by the student's dean. After the Leave of Absence or Withdrawal Form is received by Enrollment Services, it will be reviewed for appropriate tuition refunds (see Enrollment Services: Tuition and Fees Adjustment Policy) and grade implications. The recording of student courses and grades for taking a leave in a semester follows the deadlines for semester or mini courses, as follows:

- All courses or grades are removed, on or before the university deadline to drop classes with W (withdrawal) grades.
- W (withdrawal) grades will be assigned to all classes (for undergraduate students, and to graduate students only in TSB or the Mellon College of Science.), after the university deadline to drop classes but before the last day of classes:
- Permanent grades assigned by the instructor will be recorded, after the last day of classes.

Contact: Questions concerning this policy or its intent should be directed to: The HUB, x8-8186.

Student Return Policy

www.cmu.edu/policies/documents/StLeave.html

Policy Statement

Students on leave wishing to return to Carnegie Mellon to resume their degree studies may do so under several conditions. In order to be considered for return from leave, a student must first obtain a Return from a Leave of Absence form from The HUB or their academic department. This application requires information from the student regarding the intended semester of return, current address information and information about their leave. This application must be submitted to their home department at least one month prior to the beginning of the semester.

Undergraduates may return within their same academic department within two years. After two years, students returning in the same academic department are subject to space constraints and academic performance review. Graduate students must negotiate their return with their home department and must follow their department policy.

The Return from Leave of Absence form requires approval of the student's academic department and Dean. If a student's department chooses to deny the student's Return from Leave of Absence form, the student may appeal to their Dean. Any constraints governing the student's eligibility to return will be specified directly on the application by the academic department and/or Dean's office or the Office of Student Affairs.

Students who have taken courses elsewhere must submit an official transcript and course descriptions with their Return from Leave of Absence form. Transfer credit approval is determined by the academic department based on course level, performance and appropriateness to the student's curriculum requirements. Credit transfer is subject to college-specific policy. Failure to submit the necessary documents at the time of return will result in denial of transfer credit.

The process of returning is not completed until all necessary signatures on the Return form are obtained by the student and until all outstanding bills are paid. Enrollment Services will then notify the appropriate university offices of the student's return.

Contact: Questions concerning this policy or its intent should be directed to: The HUB, x88186.

Tuition Adjustment Policy

www.cmu.edu/policies/documents/TuitionRefund.html

Application

This policy applies to withdrawals and leaves of absence by all students (graduate, undergraduate, non-degree) for all semesters (Fall, Spring, Summer 1, Summer 2, Summer All).

Official Date of Withdrawal/Leave of Absence

For students who notify the university of their intent to withdraw or take a leave of absence, the official date of withdrawal or leave of absence is the earliest of:

- the date the student began the withdrawal or leave of absence process;
- the date the student notified his or her home department;
- the date the student notified the associate dean of his or her college; or
- the date the student notified the dean of students.

For students who do not notify the university of their intent to withdraw or take a leave of absence, the official date of withdrawal or leave of absence is:

- the midpoint of the semester;
- the last date the student attended an academically-related activity such as an exam, tutorial or study group, or the last day a student turned in a class assignment.

Tuition Adjustment

Students who withdraw or take a leave of absence before completing 60% of the semester will be charged tuition based on the number of days completed within the semester. This includes calendar days, class and non-class days, from the first day of classes to the last day of final exams. Breaks which last five days or longer, including the preceding and subsequent weekends, are not counted. Thanksgiving and Spring Break are not counted. There is no tuition adjustment after 60% of the semester is completed. No tuition is charged to a student who is administratively withdrawn. See The HUB website for the complete tuition assessment schedule for the current semester.

Housing, Dining Plan & Fee Adjustments

Housing charges are adjusted daily, beginning on check-in day and ending on the last day of final exams for the semester. Holiday breaks are included. The Winter Break period is not included.

Dining plan charges are adjusted per the bi-weekly period. DineXtra and PlaidCa\$h are assessed based upon actual use.

There is no adjustment of the Port Authority Fee, the Technology Fee or Student Activity fee.

Financial Aid Adjustment

Federal and institutional financial aid is adjusted on the same basis as tuition. A student earns 100% of his or her federal or institutional financial aid when 60% of the semester is completed.

State grants and non-federal outside scholarships are adjusted based upon the withdrawal policy of the agency awarding the funds.

Contact: Questions concerning this policy or its intent should be directed to: The HUB, x88186.

Student Accounts Receivable Collection Policy and Procedures

Policy Statement

A student is responsible for the payment of charges incurred at the university by the stated payment deadline. The purpose of this policy statement is to detail the specific process and action steps to be used to resolve any outstanding student account balance.

Procedural Overview

Enrollment Services will take progressive action to resolve any student account balance greater than \$500. These actions include: communication, first with the student and second with the parent/s, regarding the account status, academic and administrative consequences of nonpayment, and the provision of information and realistic payment options to resolve the delinquent balance; communication with appropriate university service administrators and the associate dean of the student's college concerning the same issues communicated to the student and parent/s.

In situations where the university attempts to resolve the outstanding balance but the student has not made or met satisfactory arrangements for payment, the university will take one or both of the following two actions: (1) financial suspension and/or (2) wage garnishment.

In the case of a financial suspension, the student will be restricted from registering for and enrolling in university courses and programs, and s/he will be prohibited from using university academic and administrative services. These services include, but are not limited to, computing facilities, library services, housing, dining, career center services, degree verification and the release of (official) academic transcripts.

If a student is employed by Carnegie Mellon, the university may garnish the student's wages to recover the amount due to the university. The cashier will notify the student prior to any action, and the amount to be garnished will be tailored to individual circumstances.

Procedures

Currently Enrolled Student/New Balance Due

Enrollment Services will notify, in writing, any enrolled student who has an account balance greater than \$500 for 20 days beyond the stated payment due date. The letter will state that s/he risks administrative action by the university, including possible financial suspension, if the student does not resolve the outstanding balance.

Graduating student with any balance due

During the spring semester, Enrollment Services will notify, in writing, any graduating student with an account balance. The letter will clearly address the outstanding balance and consequences of nonpayment. It will be mailed with the student's follow-up spring semester statement/s of student account. Any graduating student who does not clear his/her account balance prior to commencement will not receive a diploma. In addition, the student will be prohibited from using university academic and administrative services. These services include, but are not limited to, computing facilities, library services, housing, dining, career center services, degree verification and the release of (official) academic transcripts.

Currently Enrolled Students/Carry-over Balance Due

A student who received account balance action letters from Enrollment Services during the previous semester, and who has an account balance greater than \$500 following the current semester deadline for enrollment, will be subject to the following procedures.

Enrollment Services will send notification of continued nonpayment after the 15th day of classes (third week) to the student and parent/s, the university service administrators and the associate dean of the student's college. This action will be documented in the student's administrative records.

Enrollment Services will work with the student and parent/s to resolve the financial issue. Payment arrangements will follow standard practices related to collections, to include a promissory note with a specified repayment schedule within the current semester. Requests for exceptions to standard collection practices, such as extending the payment schedule beyond the current semester, must be made in writing to the vice president for enrollment. All requests will be reviewed by the Student Accounts Receivable Committee, composed of the vice president for enrollment, vice president for business, the dean of student affairs and the directors of Enrollment Services. Input from the associate dean of the student's college will be requested and considered. When a payment agreement is reached, Enrollment Services will mail a letter to the student and parent/s detailing the conditions of the agreement and the risk of financial suspension if the agreement is not fulfilled. This correspondence will be copied to representatives of the Student Accounts Receivable Committee and to the associate dean of the student's college.

If a financial agreement is not reached, the student will be financially suspended. The student will be prohibited from using university academic and administrative services. These services include, but are not limited to, computing facilities, library services, housing, dining, career center services, degree verification and the release of (official) academic transcripts for the upcoming semester. If the student is an employee of the university, the university may garnish the student's wages to recover the amount due to the university. Enrollment Services will notify the student prior to any action, and the amount garnished will be tailored to individual circumstances.

Prior to the registration period for the upcoming semester, Enrollment Services will send correspondence to any student who has a carry-over balance and who has not developed or maintained a satisfactory repayment plan. This correspondence will advise the student and parent/s that the student will be ineligible to register for the upcoming semester until s/he pays the balance in full. This correspondence will be copied to representatives of the Student Accounts Receivable Committee, university service administrators and the associate dean of the student's college. Additionally, the student will be prohibited from using university academic and administrative services. These services include, but are not limited to, computing facilities, library services, housing, dining, career center services, degree verification and the release of (official) academic transcripts for the upcoming semester.

If the student has an overdue balance at the completion of the current term (a carry-over balance greater than or equal to \$500 for 2 consecutive terms), Enrollment Services will send a letter to the student and parent/s to advise them that the student has been "financially suspended" and that s/he will not be permitted to return to the university until the account balance is paid in full. This correspondence will be copied to representatives of the Student Accounts Receivable Committee, university service administrators and to the associate dean of the student's college.

If at any point in the process the student's account balance is paid in full, Enrollment Services will update the student's enrollment status and release the hold on his/her academic and financial records. The student will then be able to register for courses and use university academic and administrative services. Enrollment Services will also notify the appropriate university academic and administrative staff members.

Delinquent Account/Financially Suspended

A student who has been financially suspended and who retains an account balance will be subject to the following procedures.

Enrollment Services will send a series of financial status letters to the student indicating the consequences of nonpayment or continued account delinquency. Enrollment Services will mail the first letter when the student is classified as having a delinquent balance, with follow-up letters at distinct intervals from the point in time Enrollment Services determines that the student's account is in a delinquent status. Enrollment Services will also use telephone conferences with the student and parent/s.

Enrollment Services will note any response to the financial status letter or telephone communication with the student and parent/s in the student's financial records, along with any arrangements for payment. Enrollment Services will update the student's account balance to reflect any payment and will assign an appropriate follow-up review date to ensure that the student continues to take action to resolve the financial delinquency.

If at any point in time Enrollment Services determines that internal collection efforts have been unsuccessful, Enrollment Services will refer the student's account to an outside collection agency. Enrollment Services will notify the student and parent/s before any referral to a collection agency.

If the student's account balance is paid in full at any point in the process, Enrollment Services will update the student's account status and release the hold on his/her academic and financial records. The student will be able to register for courses and use university academic and administrative services. Enrollment Services will notify the appropriate university academic and administrative staff members.

Contact Questions concerning this policy or its intent should be directed to: The HUB, x88186.

Financial Aid Policy Statement

University Academic Scholarship Renewals

Carnegie Mellon University awards academic scholarships as part of the freshman financial aid process. Each of these scholarships is renewable for four academic years of study (five for architecture) based upon the maintenance of a specific cumulative quality point average. The academic scholarship renewal criteria are included in the scholarship notification letter which is mailed to the student prior to the May 1 matriculation deadline.

Each scholarship recipient's cumulative quality point average is reviewed at the end of each academic year. If the student achieves the scholarship renewal criteria, then the scholarship is automatically renewed for the next academic year.

If the student does not meet the cumulative quality point average requirement for renewal, then s/he is given the opportunity to appeal. A merit scholarship appeal form and instructions are automatically sent to the student at the end of each academic year.

The student's completed appeal form is reviewed by members of the Enrollment Services staff. Input from the Associate Dean of the student's college is also considered. The student is notified, in writing, of the decision. The decision may be to renew the scholarship for the entire academic year, renew the scholarship for one academic term, or to reject the appeal. If the appeal is rejected, a written explanation is provided to the student.

Undergraduate Tuition Exchange Programs

Carnegie Mellon University assesses the standard tuition charge for the undergraduate tuition exchange programs.

Since Carnegie Mellon assesses the tuition charge, the student can be considered for all forms of institutional, state, and federal aid for which the student may have eligibility with the exception of any student employment program.

Undergraduate Study Abroad Programs

Carnegie Mellon University does not assess the tuition charge for any of the Study Abroad Programs.

Since Carnegie Mellon does not assess the tuition charge, the student is not considered for any institutional grants and scholarships. However, Carnegie Mellon will consider any student participating in an approved Study Abroad Program for all state and federal student aid programs for which the student may have eligibility with the exception of any student employment program.

The U.S. Department of Education and Carnegie Mellon University

define an approved Study Abroad Program as one which is part of a contractual agreement between Carnegie Mellon and the host institution. Additionally, courses taken in the Study Abroad Program must be accepted for transfer to Carnegie Mellon by the Dean of the student's college.

Undergraduate Sponsored Study Abroad Programs

Carnegie Mellon assesses full tuition charges and all applicable fees to students participating in an undergraduate sponsored study abroad program.

Undergraduate International Students

Documentation Eligibility (U.S. Citizenship or Eligible Noncitizen)

You must be a U.S. Citizen or permanent resident alien to receive federal student aid. If you are a U.S. Citizen, but were not born in the United States, valid documentation includes a copy of your passport or naturalization certificate.

If you are a U.S. permanent resident alien or refugee, acceptable forms of verification include a photocopy of both sides of your I-551 or I-551C card.

Undergraduate international students are ineligible to receive any federal or state student financial aid. Additionally, Carnegie Mellon does not award any institutional financial aid funds to undergraduate international students.

Statement of Assurance

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In addition, Carnegie Mellon University does not discriminate in admission, employment, or administration of its programs on the basis of religion, creed, ancestry, belief, age, veteran status, sexual orientation or gender identity. Carnegie Mellon does not discriminate in violation of federal, state, or local laws or executive orders. However, in the judgment of the Carnegie Mellon Human Relations Commission, the Presidential Executive Order directing the Department of Defense to follow a policy of "Don't ask, don't tell, don't pursue" excludes openly gay, lesbian and bisexual students from receiving ROTC scholarships or serving in the military. Nevertheless, all ROTC classes at Carnegie Mellon University are available to all students.

Inquiries concerning application of these statements should be directed to the Provost, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, telephone 412-268-6684 or the Vice President of Campus Affairs.

Carnegie Mellon University publishes an annual campus security report describing the university's security, alcohol and drug, and sexual assault policies and containing statistics about the number and type of crimes committed on the campus during the preceding three years. You can obtain a copy by contacting the Carnegie Mellon Police Department at 412-268-2323. The [security report](#) is also available online.

Obtain general information about Carnegie Mellon University by calling 412-268-2000.

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Undergraduate Academic Regulations

Availability of Required Courses

In order to insure that students do not have to compete for access to their required courses, registration priority is given to students who are registering for courses in their primary major. Although the University encourages the exploration of other disciplines, access to courses outside a student's primary major (including those courses that fulfill requirements for an additional major, minor, etc.) is on a space-available basis and is not guaranteed.

Conduct of Classes

Students are expected to attend all scheduled classes unless the instructor explicitly informs the class that other ways of doing the work are acceptable. The action to be taken in regard to tardiness, absence from class or making up late work is the responsibility of the individual instructor; the instructor should consult with the department head and the student's dean if major action, such as dropping the student from the course, is being considered.

All classes will be held at their scheduled hour on days immediately before and after all holidays and recesses. Both faculty and students are expected to be present.

Members of athletic teams and other student organizations are permitted to be absent from classes to participate in authorized contests and presentations, either at home or out of town, provided the following conditions are met:

- All work missed must be made up to the satisfaction of the instructor(s) concerned;
- No trip shall involve an absence of more than two days, excluding days when classes are not scheduled;
- The total number of days of absence shall not exceed six per sport or per organization annually;
- Each student will obtain an absence authorization signed by the director or sponsor of the organization involved and by the Dean of Student Affairs. The student will present this authorization to the instructor. This is not an excuse for work missed.

Technology affords many students access to portable devices including cell phones, PDAs, and laptops. It is expected that students will respect the wishes of faculty with regard to the use of electronic devices within the academic environment.

Students who, because of religious beliefs, cannot attend class may arrange as individuals to be absent, provided the work missed is made up in a manner satisfactory to the instructor(s) of the class(es) missed.

No student shall leave a scheduled exercise because of the absence of the instructor until a reasonable time has passed. By tradition and as a matter of courtesy a student should wait 10 minutes before leaving.

Degree Requirements

Students are responsible for checking to ensure that the degree requirements (as listed in the appropriate catalog at the time of their matriculation) have been met. They may also refer to the university's on-line academic audit website: <https://acis.as.cmu.edu/gale2/audit/degreeaudit.html>. If the degree requirements have been modified by College Council action, the student is responsible for checking to ensure that the modified requirements have been met.

In order to graduate, students must complete all residence requirements and all course requirements in their approved curriculums and be recommended for degrees by the faculty of the appropriate college. Such recommendation shall be based upon the good standing of the student in academic and disciplinary matters.

No student may receive a diploma until all financial obligations to the university have been met.

Statement on Course Attendance and Enrollment

A student is responsible for the payment of charges incurred at the university by the stated payment deadline. The purpose of this policy statement is to detail the specific process and action steps to be used to resolve any outstanding student account balance.

Students will be held financially and academically accountable for course(s) which they attend or for which they are enrolled. Enrollment in a course which is not actively taken, or contrarily, the taking of a course for which enrollment has not been completed, will result in the assignment of a grade and responsibility for applicable tuition charges.

Students who fail to resolve their enrollment and balances will be prohibited from using university academic and administrative services. The services include, but are not limited to, computing facilities, library services, housing, dining, career center services, degree verification and the release of academic transcripts for the upcoming semester.

Rank in Class

Undergraduates at Carnegie Mellon pursue degrees in one or more of our ten schools or colleges. They may choose to pursue coursework, majors and minors within and between schools/colleges. In an institution where students' educational experiences are so varied, class rank is not a meaningful way to measure achievement.

Carnegie Mellon and Enrollment Services does not report nor record students' rank in class, rank in college and rank in department. For those graduate school and/or employment requests that request a students' rank, they will be completed with the statement "Carnegie Mellon does not report rank in class."

Undergraduate Course Meetings

Usually, no undergraduate classes, exams, academic, or artistic activities (including extra help sessions, rehearsals, ROTC drill, make-up exams, etc.) are scheduled on weekdays between 4:30 p.m. and 6:30 p.m. On occasion, some courses may be scheduled during these hours by Enrollment Services when they also are offered at other times: students may elect to take such courses during the 4:30 to 6:30 p.m. period.

Diploma and Transcript Information

A Carnegie Mellon diploma is a student's certificate of accomplishment. The student's official transcript is to be considered the official record for all degree(s), major(s), minor(s), and honors.

Diplomas

The diploma is printed with the name the student approved within Graduation On-Line, along with the student's primary degree (i.e., Bachelor of Arts in Creative Writing).

Beginning in May 2008, minors will no longer be listed on the diploma, although they will continue to be indicated on the official transcript.

Diplomas are distributed to graduates during or immediately following the commencement ceremony. Certain circumstances will result in students receiving their diplomas at a later date, and such students will be informed of this well before the ceremony. If a student is unable to attend the ceremony, diplomas will be available for pick-up or mail-out in the weeks following commencement. Diplomas are not available prior to the stated date of graduation.

The diploma is 14x17 inches and is marked with a multi-colored and

gold seal.

Transcripts

The official Carnegie Mellon transcript includes both the undergraduate and graduate record. All transcripts come in individually sealed envelopes, unless otherwise specified. Transcript requests are not processed if the student has an outstanding obligation, financial or otherwise. We cannot accept phone or e-mail requests. We will not fax a transcript under any circumstances.

Visit The HUB website, www.cmu.edu/hub, for complete information, including information on ordering official transcripts.

Course Description Requests

(for prior years)

Please note that University Archives does not have access to transcript and verification information. They maintain only the course description archives. If you call or e-mail this office, your request will not be processed.

Please contact:

Archives/Art Inventory Specialist
Carnegie Mellon University Libraries
4909 Frew St.
Pittsburgh, PA 15213
(412)268-5021 (phone)
(412)268-7148 (fax)

Verifications

Enrollment verifications are available only for currently enrolled Carnegie Mellon students and Carnegie Mellon Alumni.

An enrollment verification officially confirms information about you.

Please note that we cannot fax your QPA or verifications that contain anything besides the following:

- Name
- Local address
- Local phone number
- E-mail address
- Class
- College
- Department
- Dates of attendance
- Date(s) of graduation
- Degree(s) awarded

The most common reasons for requesting a verification are:

- **Student loan agencies and insurance companies** wanting to know if a student is enrolled.
- **Scholarship committees** wanting to know if a student maintained a certain QPA.
- **Potential employers** wanting to know if a student graduated with a certain degree.

On-Line Verification Ordering

Currently enrolled Carnegie Mellon students may order enrollment verifications on-line.

- Verifications are ready in four business days (plus mailing time if applicable)
- Verifications are free, but if you have a financial hold, we **cannot** produce a verification for you until the hold is released.
- All non-faxed verifications come in individual, sealed envelopes. If you break the seam, we will not reseal the envelope.

If you do not wish to complete the verification request online, please fax a request to 412-268-8084, e-mail a request to thhub@andrew.cmu.edu, or mail a request to the following address:

Carnegie Mellon University
Enrollment Services
5000 Forbes Avenue
Pittsburgh, PA 15213-3890

Please include the following information:

- Student Name and ID Number.
- Address to which you wish the verification mailed, or choose to pick it up at The HUB.
- The information you need verified.
- If the verification is for health insurance purposes, please include the relevant policy number.

For additional information, visit The HUB website, www.cmu.edu/hub.

Grading Policies

Policy Statement

This policy offers details concerning university grading principles for students taking courses, whether those students are undergraduates, non-degree students or graduate students. This policy covers the specifics of Assigning and Changing Grades (including Final and Mid-Semester grades, Incompletes and Conditional Failures), Grading Options (Audit and Pass/Fail), Drop/Withdrawals, Course Repeats, and defines the undergraduate and graduate Grading Standards.

Questions about grading for a specific course should be addressed to the instructor of the course in question. Graduate students with questions about Pass/Fail and Drop/Withdrawal should contact their individual programs. Appeals for an exception to any grading policy may be made by the dean's office of the student's home college.

1. Definitions

Certain terms are used in this document with specific meanings, as defined in this section.

Student means any full-time or part-time degree-seeking undergraduate or graduate student, or full-time or part-time non-degree student.

Non-degree student means a student who is not in a university degree program.

Faculty means members of the university's Faculty Organization as defined in the Faculty Handbook, plus instructors and special faculty appointments (even in the first year), and part-time faculty.

Instructor means a faculty member, teaching assistant, and/or lecturer who is the instructor of record, as recorded in the Student Information System (SIS).

2. Policy Provisions

Assigning Grades

Final grades are awarded to each student, in each course scheduled, at the end of the semester, mini-semester or summer session. All students taking a course at Carnegie Mellon must be assigned grades.

Enrollment Services will query instructors who do not assign a grade to a student. Copies of the query regarding the lack of grade will be sent to the student, to the dean and to the department head. If the instructor does not assign a letter grade or an incomplete grade within one month of Enrollment Services query, the department head will be responsible for insuring that a grade is assigned.

Changing a Grade

A student who believes that an assigned grade is incorrect, may request that a final grade be changed. Final grades will be changed only in exceptional circumstances and only with the approval of the instructor and, for undergraduates, with the approval of the dean's office of the college/school offering the course; for graduate students, department approval is required. The intention of this policy is to insure that, under normal circumstances, all students in a class are treated equally and no student is unduly advantaged.

Mid-Semester Grades

Mid-semester grades provide valuable feedback to students as they assess their performance in courses. Furthermore, mid-semester grades and the QPA's they generate are used by Deans and advisors in identifying and dealing in a timely way with students in academic trouble. Therefore it is imperative that mid-semester grades accurately reflect student performance and are turned in on time.

Mid-semester grades are not permanent and are kept only until final grades are recorded. Because mid-semester grades are not permanent, changes of mid-semester grades as a rule will not be accepted.

Incomplete Grades

Carnegie Mellon students are expected to complete a course during the academic semester in which the course was taken. However, if the instructor agrees, a grade of I (incomplete) may be given when a student, for reasons beyond his or her control, has been unable to complete the work of a course, but the work completed to date

is of passing quality and the grade of incomplete provides no undue advantage to that student over other students.

In awarding an I grade, an instructor must specify the requirements for completing the work and designate a default letter grade where no further work is submitted. Students must complete the required course work no later than the end of the following academic semester, or sooner if required by prior agreement. The instructor must record the permanent grade by the last day of the examination period of that following semester, or Enrollment Services will administratively assign the default grade.

Conditional Failures

X grades are conditional failures. They are factored in the student grade point average as a failure in the semester they are awarded and can be replaced by nothing higher than a D. When awarding an X grade, the instructor specifies to the student the requirements necessary to achieve a grade of D. Requirements may be the completion of a prescribed course with a performance of C or better or may be specified work related to the course in which the student received the X. Students must complete the required course work no later than the end of the following academic semester, or sooner if required by prior agreement.

The instructor must record the permanent grade of D by the last day of the examination period of that following semester, or Enrollment Services will administratively assign the default grade of R.

Pass/Fail Grades

Undergraduate students may elect to take a free-elective course pass/fail unless precluded by the course, the course's department or the student's home department/college. Policies for graduate students vary and students should be advised to check with their individual colleges/departments/programs for details.

A student must submit a Pass/Fail Form to Enrollment Services indicating the course they are electing as pass/fail before the end of the university's drop period. This decision is irreversible thereafter. No information regarding the student's decision will be passed on to the instructor. Instructors will submit letter grades, which will automatically be converted to pass/fail.

A through D work will receive credit for units passed and be recorded as P on the student's academic record; below D work will receive no credit and will be recorded as N on the student's academic record. No quality points will be assigned to P or N units; P or N units will not be factored into the student's QPA.

In exceptional circumstances, departments may ask to designate a course pass/fail or request that the course be evaluated only with letter grades. The College Council must approve designating a course as pass/fail only or as graded only. If such a decision will have an adverse effect on the requirements of any other college, Academic Council must review the decision. The decision to designate a course as graded or pass/fail must be made before the add period for the course and is irreversible thereafter.

Audit Grades

Auditing is presence in the classroom without receiving academic credit, a pass/fail or a letter grade. The extent of a student's participation must be arranged and approved by the course instructor. A student wishing to audit a course is required to register for the course, complete the Course Audit Approval Form, obtain permission of the course instructor and their advisor, and return the form to The HUB prior to the last day to add a course.

Any student enrolled full-time (36 units) may audit a course without additional charges. Part-time or non-degree students who choose to audit a course will be assessed tuition at the regular per unit tuition rate.

Drop/Withdrawal Grades

Students at Carnegie Mellon may drop a course by accessing on-line registration on or before the drop deadline as published in the official university calendar. This applies to all courses with the exception of mini-semester courses. Policies for graduate students vary and students should be advised to check with their individual colleges/ departments/programs for details. The deadline to drop a mini-semester course is the last day of the fourth week of the mini-semester course. When a course is dropped by these deadlines, the course is removed and does not appear on the academic record.

After the deadline to drop, students may withdraw from a course by accessing on-line registration on or before the last class day, prior to the beginning of final examinations. After the deadline to drop, a W (withdrawal) grade is assigned and appears on the student's academic record. W grades do not apply to graduate students except in TSB and MCS.

Undergraduates who are registered as full-time students as of the 10th day of classes are expected to remain full-time for the duration of the semester. Full-time is defined as registered for a minimum of 36 units. Permission to drop below the 36-unit minimum can only be granted in extraordinary circumstances by the student's home Associate Dean. Undergraduates who are registered as part-time are also subject to the above deadlines to drop or withdraw from a course.

Course Repeats

When a course is repeated, all grades will be recorded on the official academic transcript and will be calculated in the student's QPA. This is the case regardless if the first grade for the course is a passing or failing grade, including Pass/Fail.

Undergraduate students who wish to repeat a course already passed must obtain approval from the student's Dean or Department Head. When a student takes a course s/he has already passed, only one set of units will count towards graduation requirements.

3. University Grading Standards

The undergraduate student Grading Standard is as follows:

Grade	Quality Points	
A	4.0	Excellent
B	3.0	Good
C	2.0	Satisfactory
D	1.0	Passing
R	0.0	Failure
X	0.0	Conditional Failure
P	Non-Factorable	Passing
N	Non-Factorable	Not Passing
O	Non-Factorable	Audit
W	Non-Factorable	Withdrawal
I	Non-Factorable	Incomplete
AD	Non-Factorable	Credit granted for work completed at another institution or examination credit

This grading standard is for all students classified as seeking an undergraduate degree and special students taking undergraduate courses.

Any +/- grades received by undergraduate students when taking graduate-level courses will automatically convert to the corresponding letter grade as listed in the scale above.

The graduate student Grading Standard is as follows:

Grade	Quality Points	
A+	4.33	(Not applicable to CIT or H&SS)
A	4.00	
A-	3.67	
B+	3.33	
B	3.00	
B-	2.67	
C+	2.33	
C	2.00	
C-	1.67	
D+	1.33	
D	1.00	(Not applicable to TSB, HNZ or H&SS)
R	0.00	Failure
X	0.00	Conditional Failure
S	Non-Factorable	Satisfactory
P	Non-Factorable	Passing
N	Non-Factorable	Not Passing
O	Non-Factorable	Audit
W	Non-Factorable	Withdrawal
I	Non-Factorable	Incomplete
AD	Non-Factorable	Credit granted for work completed at another institution or examination credit

Grading standards are based upon a student's home academic program and is defined by their home college. The college's standards determine if certain grades are applicable and if undergraduate course are factored into their mid-semester and final

semester quality point averages (QPA). Otherwise, the university policy is that only graduate courses (700 level and higher, unless a department specifies 600 level as graduate) are factored into the semester QPA.

Pass/Fail policies for graduate students vary and students should be advised to check with their individual college/department/program for details.

Minimum passing grades in graduate courses are determined by the department and college policy. Any course that a graduate student completes will be graded using this scale.* This includes undergraduate courses taken by graduate students, and non-degree students taking graduate courses.

Contact

Questions concerning this policy or its intent should be directed to Enrollment Services, 8-8186.

Units and Quality Points

Carnegie Mellon has adopted the method of stating in "units" the quantity of work required of students. In each subject of study, the college catalog tells how much time per week is expected of the average student for each kind of work (e.g., recitations, laboratory, studio, study). For the average student, one unit represents one work-hour of time per week throughout the semester. The number of units in each subject is fixed by the faculty of the college offering the subject. Three units are the equivalent of one traditional semester credit hour.

A subject requiring 9 hours of the average student's time per week for a semester is known as a 9-unit subject. For example, Chemistry might require 3 hours in the laboratory, 3 hours of lecture/recitation and 3 hours of preparation, a total of 9 work hours. Mathematics might require 3 hours of recitation plus 3 hours of preparation for each recitation, a total of 12 work hours.

Final grades are given "Quality Point Values" as follows:

A	(excellent)	= 4
B	(good)	= 3
C	(satisfactory)	= 2
D	(passing)	= 1
R	(failure)	= 0

Units earned for a course multiplied by the Quality Point Value of the grade given for that course equals the Quality Points for that course. For example, a 9-unit course assigned a "C" grade is awarded 18 quality points (9 units x 2 quality points = 18 quality points). Total Quality Points divided by Total Units Factorable equals the Quality Point Average.

For example, a student's record in one semester might be:

11 units in Mathematics "A"		
11 units x 4 quality points	=	44 quality points
10 units in Physics "R"		
10 units x 0 quality points	=	0 quality points
9 units in Chemistry "B"		
9 units x 3 quality points	=	27 quality points
9 units in History "C"		
9 units x 2 quality points	=	18 quality points
9 units in English "D"		
9 units x 1 quality point	=	9 quality points
Total Units = 48		
Total Quality Points = 98		
Quality Point Average (98 divided by 48) = 2.04		

"I" (incomplete), "P" (pass), and "W" (withdrawal) grades are not awarded quality points and are not considered as "factorable" units when calculating the QPA.

The same procedure is applied to all grades earned at the university to establish the Cumulative Quality Point Average.

Transfer Credit Evaluation and Assignment Policy

The Policy on Grades for Transfer Courses, originally dated January 13, 1993, and approved by the Committee on Educational Programs and Student and Faculty Affairs states:

"Carnegie Mellon University offers students the opportunity to take courses for credit through a cross-registration program and through the receipt of transfer credit from other accredited institutions. The Carnegie Mellon University transcript will include information on such courses as follows:

Carnegie Mellon courses and courses taken through the university's cross-registration program will have grades recorded on the transcript and be factored into the QPA. All other courses will be recorded on this transcript indicating where the course was taken, but without grade. Such courses will not be taken into account for academic actions, honors or QPA calculations. (Note: Coursework taken when a student is on suspension is not acceptable for transfer credit.)

Definitions

A Carnegie Mellon course is one conducted under Carnegie Mellon University regulations regarding course content and grading and taught by faculty under the supervision of a Carnegie Mellon academic unit. Courses taught by Carnegie Mellon faculty on the Carnegie Mellon campus qualify. Courses that are part of the regular offerings of other universities do not qualify, unless faculty at the other universities receive appointments at Carnegie Mellon and handle Carnegie Mellon students under Carnegie Mellon academic regulations.

Courses offered for cross-registration are those taken under the PCHE (Pittsburgh Council on Higher Education) agreement during the regular academic year."

Only official and final college or university transcripts will be accepted for the awarding of transfer credit. Grade reports, letters and the like are not acceptable. It is the responsibility of the Offices of Enrollment Services and Admission to verify official transcripts. Official transcripts for the awarding of transfer credit will reside in the student's permanent university academic folder in the Office of Enrollment Services.

It is the responsibility of each academic department to review and establish transfer course credit for their degree-seeking students.

Transfer Credit Evaluation Procedure External Transfer Students

External applicants applying for transfer to Carnegie Mellon will arrange for submission of:

- official transcripts to the Office of Undergraduate Admission as part of the admission process.
- official, final transcripts to the Office of Undergraduate Admission once they are admitted and prior to their beginning coursework at Carnegie Mellon.

As part of the admission process, Admission will verify the official final transcripts, and then send them to the appropriate academic unit responsible for college/department acceptance decisions. Each unit will be responsible for student's review of transfer credit and the establishment of transfer course credit for each individual student.

Current Students

Current Carnegie Mellon students taking courses at other accredited institutions (colleges and universities), during either summer semesters or as part of exchange programs or other departmentally approved programs, or while on leave from Carnegie Mellon, must arrange for the submission of official final transcripts to the Office of Enrollment Services.

Upon receipt, Enrollment Services will verify these official transcripts and send a copy of the transcript to the appropriate academic unit responsible for that student's college/department transfer credit decisions. The official transcript will reside in the student's university academic folder in Enrollment Services. Each unit will be responsible for its students' transfer credit review and the establishment of transfer course credit for each individual student. Should a unit receive the official transcript, it must be sent immediately to Enrollment Services.

Procedure for the Appeal of Grades & Academic Actions

Students who believe that a grade which has been awarded to them is incorrect or that an academic action, recommended by their department and approved by the College Council, is unreasonable or inconsistent with the practice of the college should use the following procedures for prompt and equitable resolution of the grievance.

In the case of grades the student must:

1. Present the case verbally to the faculty or staff member responsible for the course in which the student believes an inappropriate grade has been awarded.
2. Present the grievance in written form with appropriate documentation to the department head of the department responsible for the course if Step 1 does not resolve the grievance. The department head will provide within 30 days a written decision and the basis for it in the matter of the grievance.
3. Present copies of all documents originally sent to the department head in Step 2 and a formal letter of appeal to the College Council of the college responsible for the course if the student believes that Step 1 does not adequately resolve the grievance or if no decision has been rendered within the 30 days provided for in Step 2. The Dean of the college, acting for the university, will respond in writing with prompt and equitable resolution of the complaint, normally within 30 days and will document the basis for the College Council's decision.

In cases in which the student believes an academic action recommended by the head of the department and approved by the College Council is inconsistent with the policies of the college or incorrect, the student should use the following procedure:

1. In writing, the student must petition the College Council to make a formal review of the appropriateness of the action, such review to take place at the next scheduled meeting of the College Council.
2. The Dean of the college will provide in writing within 30 days after the next scheduled meeting of the College Council the response of the council to the petition and the basis for it.

If, after carrying out the steps described above as appropriate, the student believes that the matter is not adequately resolved or if no decision has been rendered on the last step outlined for the particular grievance, the student must present copies of all documents and a formal letter of appeal to the Provost or another university officer designated by the President for resolution of the grievance. That officer, acting for the university, will respond in writing with prompt and equitable resolution of the complaint, normally within 30 days, and will document the basis for the decision.

Graduation with University Honors

In recognition of exemplary academic achievement as undergraduates, some candidates for undergraduate degrees will be named to the University Honors List. Each of the undergraduate colleges will select students for honors on the basis of a cumulative grade point average (typically when cumulative QPA is greater than 3.5) and/or recommendation of the faculty.

Overloads

The University is committed to insuring that each degree candidate has access to a normal course load before it permits other students to register for a greater than normal number of units. A normal course load has been established by each academic department. Students should check with their academic advisor, department head, or dean's office for the definition of a normal course load. Individual colleges may have overload policies that are more restrictive, therefore students should consult with their advisor when considering an overload. Students may register for an overload up to 12 units with the approval of their academic advisor if they have demonstrated their ability to successfully complete a normal course load. Successful completion of a normal course load is defined as having earned at least a 3.00 (3.50 for students in ECE) cumulative QPA through the preceding semester or at least a 3.00 (3.50 for students in ECE) semester QPA in the current semester (in which case all final grades must be recorded before the student can register for the overloaded class). Overloads greater than 12 units or other exceptions must have the approval of the student's Associate Dean. Freshmen and transfer students are limited to a normal course load in their first semester of attendance.

Free Electives

A free elective is any Carnegie Mellon Course. However, a maximum of nine units of physical education, military science (ROTC), and/or student-taught (StuCo), courses may be used toward fulfilling graduation requirements.

Residency Requirement

A candidate for the bachelor's degree must complete at the university a minimum of four semesters of full-time study, or the equivalent of part-time study, comprising at least 180 units of coursework. Note that these are minimum residency requirements applicable to all university undergraduates. Some of the university's colleges and departments have developed more restrictive requirements in this area. Students should consult that section of the catalog in which their college or department's academic regulations are presented for the residency requirements applicable to them. Deviation from these policies requires action by the Dean of the student's home college.

Implications of Residency Requirements for transfer students seeking second undergraduate degree: Students who received degrees from other universities could have up to 2 years of credits earned elsewhere applied to their Carnegie Mellon degree requirements and would need to meet Carnegie Mellon's Residency Requirement and complete at the university a minimum of four semesters of full-time study, or the equivalent of part-time study, comprising at least 180 units of coursework. Deviation from these policies will require action by the Dean of the student's home college.

Standard Course Equivalents for Advanced Placement/International Baccalaureate Units Policy

The university has standard units assigned to Advanced Placement (AP) and International Baccalaureate (IB) credits for all majors. Standard course equivalencies for each exam will be determined by "expert departments" in each college for each acceptable AP/IB score.

Under this procedure, students' AP or IB credit for a particular course will only go toward their degree requirements if allowed by the home department or college policies. Should a student decide to transfer to another major and/or academic unit within the university, AP/IB credits applicability to new degree requirements will depend upon the requirements of the new home department (or college). Students may only be granted credit for the Higher Level IB exams. This policy assumes no significant AP and/or IB exam changes. In the event of significant exam changes, students will be notified of any resulting policy changes no later than July 30 prior to their enrollment to take effect the fall of that year.

Standard Degree Terminology

Carnegie Mellon University offers a wide variety of programs; the opportunities vary greatly between and among the colleges. For the purposes of clarification, this section defines:

- standard degree terminology;
- changes to the existing degree declaration process;
- the existing procedure for creating new degrees, majors and minors.

Degree

Examples: B.S. (Bachelor of Science); M.F.A. (Master of Fine Arts); Ph.D. (Doctor of Philosophy)

Major

Field studied in greatest depth by fulfilling a department-determined set of course requirements. The primary major is the field in which the degree is granted.

Example: Creative Writing; Physics; Marketing

Students may pursue an additional major(s) in a single degree program.

Minor

Field(s) studied for educational enrichment by fulfilling a department-determined set of course requirements. Graduate

students may not pursue Minors. Minors are not listed on the diploma but appear, instead, on the student's transcript. The type of degree sought is determined by the major (that of the home department), not the minor(s). Examples: Film Studies; History of Ideas

Option

(Now referred to variously as track, option, etc.)

A specific area of study associated with the major or additional major(s), which transforms the title of the major or additional major.

Examples: Civil Engineering (Biomedical Engineering Option)
Physics (Computer Science Option)

Concentration

(Now referred to variously as track, option, etc.)

A specific area of study generally associated with a major or an additional major, which appears only on the transcript.

Home College

The college into which the student was originally admitted or into which the student formally transferred.

Home Department

The department into which the student was originally admitted or the department offering the major which the student has declared.

Concurrent College/Department

College/department other than the home college/department, granting the second of multiple degrees, or offering the additional major(s) of double or triple major, or minor.

Single Degree/Major

One diploma, stating the degree and the major field of study. Currently, the Statute of Limitations on earning an undergraduate degree is eight years.

Examples: B.A. in Psychology; M.S. in Industrial Administration

Requirements: Fulfillment of all requirements of the home college.

Declaration: At least by registration time (early November), first semester junior year.

Certification: Home college, home department

Major - Declaration Process

For undergraduates, depending on the student's college, the major is usually declared at the end of the freshman or sophomore year. Departments enter the appropriate majors into the Student Information System upon declaration.

For graduates, the major is usually indicative of the department and is supplied by the department via SIS.

Joint Degree

Degree program offered between two or more colleges/departments or offered in conjunction with an outside University.

Examples: M.S. in Colloids, Polymers, and Surfaces (Chemistry and Chemical Engineering); B.H.A from College of Fine Arts and Humanities and Social Sciences.

Multiple Degrees

More than one degree granted by the university (whether simultaneous or sequential). One diploma for each degree. When awarded simultaneously, two degrees are referred to as dual degrees, three degrees as triple degrees. Multiple graduate degrees may be given in conjunction with (an) outside University(ies).

Examples of how such degrees appear on the respective diplomas:

Bachelor of Fine Arts in the field of Art; Bachelor of Science in the field of History

Bachelor of Science in the field of Physics; Bachelor of Science in the field of Computer Science

Requirements: Multiple bachelor's degrees

Declaration: Undergraduates: at least by registration time (early November), semester junior year

To receive multiple bachelor's degrees the student must:

- satisfy all requirements for each degree.
- complete a number of units determined as follows: the aggregate number of units must exceed by at least 90 the required number of units for at least one of the degrees. (For example: if one of two degrees requires 365 units and the other requires 380 units, a total of at least 455 units is required to obtain both degrees.)
- comply, for each degree, with the statute of limitations regarding the time at which units are earned.
- while working towards more than one degree simultaneously, designate one of the departments (and if necessary colleges) as the home college/department.

Additional Major

One degree, stating the major in the home department first and the additional major second. The type of degree given (B.A., B.S.) is determined by the major of the home department.

For example, a student whose home department is Physics:

This degree is valid: B.S. in Physics with an additional major in History

This degree is not valid: B.S. in History with an additional major in Physics

The intent of a double major is an in-depth understanding of two major fields. Students may pursue a second major in a field where the primary degree is different from the degree associated with the additional major: e.g., B.S. in Economics with an additional major in History.

Requirements: If the double majors involve two different colleges OR the same college, the student must fulfill:

- all requirements (including core) for the first major degree as defined by the home college;
- all major requirements (including core prerequisites) for the additional major;
- any specific requirements for double majors imposed by the department(s)/college(s) involved.

Declaration: At least by registration time (early November), first semester junior year.

Certification: Home college, home department; concurrent college (if any), concurrent department (if any).

Additional Majors

One degree, stating the major of the home departments first, the second and the third major afterwards. The type of degree sought (B.A., B.S.) is determined by the major in the home department.

For example, a History student, this degree is valid: B.A. in History with additional majors in Professional Writing and in Hispanic Studies. This degree is not valid: B.A. in Professional Writing with additional majors in History and in Spanish.

Requirements: If the triple major involves two or three different colleges OR the same college, the student must fulfill all requirements listed for each additional major.

Declaration: At least by registration time (early November), first semester junior year.

Certification: department

Concurrent college (if any), concurrent department (if any)

Second concurrent college (if any), second concurrent department (if any)

Minor

One degree, stating the major first and the minor second (or third, if there is also (an) additional major(s) involved). The type of degree sought (B.A., B.S.) is determined by the major (that of the home department). Minors are not listed on the diploma, but appear on the transcript.

Examples: B.F.A. in Music Performance (Voice) with a minor in Theatre Arts; B.S. in Applied History with an additional major in Information Systems and a minor in Mathematics.

Requirements: The student would generally take 45 units pertaining to the minor, in addition to fulfilling all requirements for the major degree (as defined by the home college). The "minor" courses are

negotiated between the student and the department certifying the minor.

Declaration: At least by registration time (early November), first semester junior year.

Certification: department

Options (Tracks, Specializations, Area Cores, etc.)

These concentrations will not be considered part of the student's degree title unless included are part of the major or (an) additional major(s) field title.

Additional Majors/Minors Declaration Process

For undergraduates, all variations on a student's sought degree and major field must be declared by the end of the first semester of the student's junior year. Having already declared a major, students should be well prepared by this time to choose additional majors and/ or minors.

It is assumed that by these proposed deadlines, the student will have taken a majority of degree requirements and electives. The student can then, in conjunction with an advisor, review his/her course history and decide which options may or may not apply towards the desired degree and field(s).

A student who wishes to pursue additional majors and/or minors should consult with his/her advisor and receive a detailed curriculum for attaining the additional desired degree, major or minor. The student should then notify the college/department offering the additional program. Upon receipt of this notification, the college/department will update the Student Information System which will reflect this information to the Commencement System for graduation. This procedure ensures that when a student is expected to graduate, all degree/major information is immediately accessible, and certification of the degree is simplified.

Multiple Degrees Involving Graduate Degrees

Policies involving multiple graduate degrees or a graduate/undergraduate degree program or sequence are dictated by each college involved.

Examples: M.S. in Public Management and Policy and the degree of Juris Doctor (Heinz School/University of Pittsburgh School of Law).

Declaration: Undergraduates: at least by registration time (early November), first semester junior year.

Declaration: Graduates: upon admittance OR by the end of the semester preceding the expected graduation date.

Certification: Home college, home department and concurrent college (if any), concurrent department (if any).

Transitional Students

Transitional student status has been instituted by the university to assist students who have changed their minds about their original field of study or who have been judged unlikely to make satisfactory progress in their chosen field. Becoming a Transitional Student gives a student an opportunity to maintain a relationship with the home college while re-orienting academic plans and goals. It also gives a student time to explore his/her options and/or enhance admissibility to another college in the university, or to another institution. Ordinarily, a student will be permitted to register as a Transitional student for no more than one semester. Although, in exceptional circumstances, a student may be allowed to extend the status beyond one semester. A student must obtain the permission of his/her home college Associate Dean to initiate this option.

Transitional student status may be available to students upon the advice of their advisor, or upon their own request. Interested students must make an appointment with the Associate Dean of their home college to discuss this option.

Note: Students at Carnegie Mellon in good academic standing may transfer from one program to another as long as they meet curricular or artistic requirements and as long as there is space in the program into which they wish to transfer.

Process for Creation of New Degrees, Majors, Minors

Departments proposing new degrees, majors, additional majors, and/or minors must complete a New Degree/Major/Minor Request Form. This should include any and all notations to the university diploma and/or transcript (new degrees, majors, minors, options). Departments proposing to offer a new degree, major, additional major and/or minor must follow university policies for approval as follows:

- Document the Program by completing the New Degree/Major/Minor Request Form. Departments proposing new degrees and majors must complete this form and attach course descriptions, curriculum proposal, list of present faculty who will support the Program, and verify the availability of other units' courses. This documentation must indicate the starting semester for the Program, and in the case of new majors, also indicate if it is available only as a major/additional major/minor, or in combination.
- Receive Department approval.
- Receive Dean and College Council approval.
- Submit all Program documentation complete with College Council approval to the Vice Provost for Education. New majors or degrees will not be processed without the approval of the Provost's Office.
- The Provost's Office will approve or deny, and inform the sponsoring Department and Enrollment Services.
- The Department may then publicize and offer the program for student enrollment.

Status, Class Standing

Students should refer to the sections of the catalog pertaining to their college and/or department to determine the number of units required each academic year by their specific curriculum. Students must achieve passing grades in order to earn units; students do not earn units for incomplete or failed courses.

A freshman student becomes a sophomore after earning passing grades in three-fourths of the units required by his/her freshman curriculum.

A sophomore student becomes a junior after earning the number of units required by his/her curriculum for the freshman year plus three-fourths of the number of units for the sophomore year.

A junior student becomes a senior after earning the number of units required by his/her curriculum for the freshman and sophomore years plus three-fourths of the number of units for the junior year.

Classification of students is made only at the time of their first registration in any academic year and remains unchanged throughout the rest of that academic year.

Retention of Student Work

The university reserves the right in all colleges to retain indefinitely any student work the faculty may select. All work not retained by the university must be claimed at the time specified on the bulletin boards (or other forms of communication) of the department concerned; otherwise, the work will be destroyed.

Statute of Limitations

All units required for an undergraduate degree, whether earned in residence, transferred from another institution or granted via advanced placement, must have been earned within eight years of the date on which the degree is granted. This statutory period can be extended by the Dean of the student's college under the following conditions:

- the courses taken prior to the statutory period still represent a reasonable part of the student's total academic program;
- the prior courses provide adequate preparation for courses which must still be taken to fulfill the degree requirements;
- there is a legitimate reason(s) for the student not completing the academic program within the statutory period.

A request for a waiver of the statute of limitations must be submitted to the Dean of the student's college. The request for a waiver should address all of the above conditions for an extension. For cases in which a waiver is granted, the waiver covers specific courses and is intended for a specific period during which the program must be completed.

Student Suspension/Required Withdrawal Policy

Policy Statement

University Suspension is a forced, temporary leave from the university. There are three types of suspension for students that apply to both graduate and undergraduate students:

Academic Suspension is the result of poor academic performance or violation of academic regulations and is imposed by the student's college or academic department (see university and college academic policies).

Disciplinary Suspension is the result of serious personal misconduct and is imposed by the Office of Student Affairs (see The Word/ Student Handbook).

Administrative Suspension is the result of failure to meet university financial obligations or failure to comply with federal, state or local health regulations and is imposed by Enrollment Services. (See Student Accounts Receivable Collection Policy and Procedures for financial obligations. Contact Student Health Services for information about health regulations.)

Suspended students may not:

- register for courses
- attend classes
- live in residence halls or Greek housing
- use campus facilities, including athletic facilities, library and computer clusters
- participate in student activities
- be members of student organizations
- have student jobs

(Note: students on academic suspension may have a summer campus job if they accepted the job before they were suspended.)

Employment

Although suspended students may not hold student jobs, students on academic suspension may, under certain circumstances, have a non-student job with the university; students on disciplinary or administrative suspension may not.

To have a non-student job, students on academic suspension must receive approval from their associate dean (undergraduate students) or department head (graduate students) to ensure that the job will not violate their suspension terms. Students in violation of this will lose their degree student status, meaning they would have to reapply for admission to Carnegie Mellon through either Undergraduate Admission or the appropriate graduate department.

Transfer Credit

Suspended students may take courses elsewhere; however, they may receive transfer credit only if their college's and department's policies allow this.

Appeals

To appeal any action of this policy, the student may write to the following people:

Academic Suspension - associate dean (undergraduate students) or department head (graduate students);
 Disciplinary Suspension - dean of student affairs;
 Administrative Suspension - vice president for campus affairs, vice president for business and planning, and the dean of student affairs, in consultation with the student's associate dean.

Returning from Suspension

In order to return from a suspension, a student must have the following approval:

Academic Suspension - associate dean (undergraduate students) or department head (graduate students);
 Disciplinary Suspension - dean of student affairs;
 Administrative Suspension - vice president for campus affairs or his designate.

Contact

Questions concerning this policy or its intent should be directed to The HUB, x88186.

Level of English Fluency Needed for Non-Native English Speakers

To be successful at Carnegie Mellon University, students who are nonnative speakers of English need to begin their undergraduate work with a strong foundation in academic English and a high level of proficiency with speaking, reading and writing in English. The importance of English language abilities cannot be overstated since there are no basic ESL language courses at Carnegie Mellon. All students will have sufficient English language proficiency to be able to participate fully in the academic work and to interact in daily life outside of the classroom.

Students' English fluency will enable them to handle the demands of academic work, including the ability to comprehend, process, and master complex material presented in English, both in written and spoken form. Students will possess the fluency to communicate their ideas and questions to faculty, classmates, and others, in a classroom environment that is often highly participatory. For example, many classes require group discussion, team projects, oral presentations, and/or independent research. In addition to fluent English skills, studying in a new culture requires openness and flexibility to adapt to a new, and often very different, academic system.

To assess the language of nonnative speaking applicants, a minimum TOEFL score of 600 (paper based, PBT), or 100 (internet based, iBT) has been established as the standard for admission. This minimum score indicates that an applicant has the fundamental building blocks of language needed for academic tasks and for continued language development. Since neither the PBT or CBT versions of TOEFL assess speaking, students who took these tests should additionally seek feedback on their speaking skills and work to improve conversational skills before beginning academic work.

Exchange Students

Each term, Carnegie Mellon welcomes exchange students from partner institutions around the world. Exchange students enrich the learning experience at Carnegie Mellon and are expected to be full participants in the curricular and metacurricular life. Therefore, their admission should adhere to the English language guidelines described above. Exchange students submit standardized English language testing scores (such as the TOEFL) as part of the Exchange application process, and present the same high level of English language abilities as degree-seeking students. With exchange students, high-level English abilities are particularly critical since academic, personal and extracurricular experiences must be maximized in a short period of time sometimes only four months in duration.

Withdrawal of a Degree

The university reserves the right to withdraw a degree even though it has been granted should there be discovery that the work upon which it was based or the academic records in support of it had been falsified. In such a case the degree will be withdrawn promptly upon discovery of the falsification.

Information for Graduates

Graduating students may wear one stole ONLY with their academic regalia. Students are certainly permitted to receive/purchase more than one stole if they are a member of multiple organizations that issue stoles and may chose to wear a particular stole to the main commencement ceremony and another to their diploma ceremony.

Graduating seniors that are a member of a club/organization that issues a pin to designate affiliation are permitted to wear more than one pin with the academic regalia in addition to one stole.

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University Services

Assistance for Individuals with Disabilities

Equal Opportunity Services
Whitfield Hall, 143 N. Craig Street, Pittsburgh PA 15213
<http://hr.web.cmu.edu/eos.html>

Everett Tadem, Director (412) 268-2012
et19@andrew.cmu.edu

Larry Powell, EOS Manager (412) 268-2013
lpowell@andrew.cmu.edu

Courtney Bryant, EOS Administrative Coordinator (412) 268-2012
cbryant@andrew.cmu.edu

Qualified individuals with disabilities are entitled to reasonable accommodations under the Americans with Disabilities Act (ADA regulations). Accommodations are determined on a case-by-case basis. Equal Opportunity Services provide links between individuals with disabilities and the campus community. Information released will provide documentation of a disability for faculty, staff, students and prospective students of Carnegie Mellon University. All information will be considered confidential and only released to appropriate personnel on a need to know basis. To access services, individuals must initiate a request in writing for specific services/accommodations (books on tape, enlargements, interpreters, etc.). Accommodations prescribed only apply to Carnegie Mellon University and may not be valid elsewhere. The individual takes full responsibility for ongoing assistance.

In order to receive services/accommodations verification of a disability according to Carnegie Mellon guidelines is required.

To establish that an individual is covered under the ADA, the documentation must indicate that the disability substantially limits some major life activity, including learning. The documentation requirements are provided in the interest of assuring that a disability demonstrates an impact on a major life activity, is appropriate to verify eligibility, assures the implementation of appropriate accommodations, and supports the request for accommodations, academic adjustments, and/or auxiliary aids.

For more information on disability resources and documentation guidelines please contact Larry Powell, EOS Manager (412) 268-2013– lpowell@andrew.cmu.edu or visit our website at, <http://hr.web.cmu.edu/eos.html>

Carnegie Mellon Resource Advising Center (CMARC)

Ty Walton, Director
Damian Dourado, Asst. Director
CMARC Office: Cyert Hall A64, 8-2150

The Carnegie Mellon Advising Resource Center (CMARC) is an advising and information center that assists students and connects them to appropriate communities, services and opportunities by providing academic planning and one-on-one counsel. Founded as the Carnegie Mellon Action Project (CMAP), CMARC has an additional commitment to support underrepresented ethnic minority students in a setting where students' differences and talents are guided, appreciated, and reinforced.

Academic Advising

CMARC, working in cooperation with faculty and departmental advisors, strives to promote academic success. The professional program advisors serve as an additional resource when it is necessary to consult with more than one person or to obtain another perspective. Their primary objective is to assist students in developing and achieving meaningful educational plans that are compatible with their life goals. CMARC advisors can help students:

- Establish short and long term academic goals.
- Investigate alternative majors in other colleges.
- Obtain referrals to organizations such as Career Services, Academic Development, etc.
- Explore career and graduate school options.

Computing Services

Joel Smith, Vice Provost Computing Services
Cyert Hall 283, x8-2649
<http://www.cmu.edu/computing/>

The Computing Services division develops, maintains and supports the computing, instructional technology and telecommunications resources for the students, faculty and staff of Carnegie Mellon. The division maintains the campus wired and wireless network and public computer clusters. They are also responsible for system software development and cable TV and telephone services such as voicemail and long distance. Computing Services also installs and maintains the audio/video equipment in most of the academic classrooms. Visit <http://www.cmu.edu/computing/> for additional information.

Policies and Guidelines

The Carnegie Mellon Computing Policy establishes general rules for the use of computing, telephone and information resources. The policy is supported by a number of guidelines. All campus affiliates own the responsibility to read and be familiar with the policy and guideline statements available at <http://www.cmu.edu/computing/guideline/>.

The Portal Software and Account Services

Use the Carnegie Mellon web portal at <http://my.cmu.edu/> to easily access a variety of information and services on the web. Through the Portal "My Accounts" tab, you can change your Andrew password, set mail forwarding and download software.

Student Advisory Council

<http://www.cmu.edu/computing/ed-outreach/sac/>

The Student Advisory Council (SAC) meets monthly to articulate the student body's computing needs and perspectives to members of Computing Services. Students who are interested in becoming SAC members can do so through the SAC web site.

The Help Center

Cyert Hall 119, x8-HELP
<http://www.cmu.edu/computing/repair/help-center.html>

The Help Center technical staff answers questions related to computing at Carnegie Mellon. Consultants are available on weekdays by telephone between 7 a.m. – 7 p.m. and in person between 9:00 a.m. to 5:00 p.m. For non-urgent matters, contact the Help Center via email to advisor@andrew.cmu.edu. The Help Center also handles computer account issues; a complete account directory is available at <http://www.cmu.edu/directory/>.

Information Security Office

Cyert Hall, x8-8556
<http://www.cmu.edu/iso/>

The Computing Services Information Security Office (ISO) ensures the safety and security of the campus computing environment. The office maintains a web presence that offers links to security downloads and patches to secure your computer.

Computing Clusters

x8-8776
<http://www.cmu.edu/computing/clusters/>

Cluster Services provides 400 UNIX, Macintosh, and IBM-compatible computers in seven public computer labs known as "clusters". Most clusters are open 24 hours per day when classes are in session and have a consultant on duty to answer basic computing questions. In conjunction with the College of Fine Arts, Cluster Services also

operates the Multimedia Studio located in the College of Fine Arts building. The Multimedia Studio provides students with the multimedia digital equipment for digital video, animation, and computer modeling, digital imaging, digital sound recording, music composition, and large format color printing. This facility is available to the campus community with preference for CFA courses and coursework.

Telecommunications

Bramer House, x8-8500
<http://www.cmu.edu/computing/network/phone/>

Telecommunications provides telephone services to students, faculty, and staff including lines, equipment, maintenance, voicemail and long distance. Telecommunications also manages the university's Cable TV services.

For More Information

A comprehensive collection of computing documentation is available on line at <http://www.cmu.edu/computing/documentation/>. Printed copies of some of these documents are also available at the Help Center in Cyert Hall 119. For information that is geared to new students, faculty or staff members, visit the new user web site at <http://www.cmu.edu/computing/new-user/>.

Division of Student Affairs

G. Richard Tucker, Interim Dean of Student Affairs
 Warner Hall 301

As much of undergraduate education focuses on preparation for professional careers, the university is strongly convinced that the total development of the student is critical to preparation for professional practice. A great deal of time and effort by the Division of Student Affairs, faculty and the university staff focuses on providing students with the opportunities to expand experiences outside the classroom, to encounter new intellectual and social experiences, to undertake projects for personal growth, and to prepare for life.

Our vision and mission for the student experience is founded upon the intellectual, occupational, emotional, spiritual, physical, and cultural growth and nurturing of students. The Division of Student Affairs, and our partners throughout the university, are here to support you in reaching your highest potential in the areas of artistic and intellectual curiosity, personal well being, professional competency, leadership development, and engagement in and contribution to the larger community.

Staff members throughout the division are here to support and foster your intellectual and personal growth and help you explore and experience the different aspects of college life. We care about you, your studies, your social growth, your well-being and your future and want to help you enjoy a great Carnegie Mellon experience. Offices within the Division of Student Affairs include:

- Office of the Dean of Student Affairs
- Career Center
- Counseling and Psychological Services
- Health Services
- Office of International Education
- Office of Orientation and First Year Programs
- Office of Student Activities
- Student Development Office
- Student Life Office

Office of the Dean of Student Affairs

Warner Hall 301, 412-268-2075, <http://www.studentaffairs.cmu.edu/dean.cfm>

G. Richard Tucker, Interim Dean of Student Affairs, Paul Mellon University Professor of Applied Linguistics

The Office of the Dean provides central guidance and direction of student services at Carnegie Mellon. The dean is responsible for leading the Division of Student Affairs in providing students with quality services, programs, and experiences that support and complement the academic mission of the university.

While students are encouraged to seek out any member of the division for assistance, you may also meet with the dean of student affairs directly by calling 412-268-2075 and scheduling an appointment at your convenience.

Career Center

University Center Lower Level, 412-268-2064, <http://www.cmu.edu/career>

Lisa Dickter, Interim Director

Career exploration and planning

Whether you are interested in exploring post graduation options, or are clear on the direction you plan to pursue, the Career Center offers a complete range of resources. Students wishing to explore how majors and minors relate to career choice, as well as gain information about particular fields, will work with a career consultant to examine their skills, interests, and values and subsequently various career fields. Career consultants also coach students in writing resumes and cover letters, networking, locating internship and job opportunities, preparing for interviews, and pursuing graduate school opportunities. Career consultants are assigned to each college and provide individualized support, general career programming, and college-specific workshops. Finally, the Career Center library and web page provide extensive resources on job search strategies, internships, summer opportunities and other career-related areas.

Job search

Several thousand summer internships and professional full-time job opportunities are made available to students through TartanTRAK, our on-line job listing resource. Students can access TartanTRAK through the Career Center's homepage. TartanTRAK also provides information regarding the pool of 600+ employers that visit our campus each year. These organizations interview students for internships and professional employment as well as hold informational sessions in the evenings which are open to the entire campus. Average starting salaries offered to Carnegie Mellon graduates, in most fields, consistently rank above the national norms.

Student employment/Campus jobs

The Student Employment program promotes experiential learning and professional development. All campus job postings include learning objectives that help employers and students recognize and understand the professional and personal opportunities for growth. The Student Employment website includes an on-line training and orientation program that covers the basics of business etiquette to the essentials of getting paid on time.

Student employment opportunities are posted on-line through TartanTRAK and include federal, state, community service work-study jobs as well as non work-study jobs. Having a work-study award does not guarantee a job. All students interested in working on campus are responsible for finding and applying for a campus job.

Counseling and Psychological Services

Morewood Gardens E-Tower, 412-268-2922, <http://www.studentaffairs.cmu.edu/counseling>
 Cynthia Valley, Director

Counseling and Psychological Services (CAPS) at Carnegie Mellon offers students the opportunity to talk about personal or academic concerns in a safe, confidential setting. Students come to CAPS for many reasons, including but not limited to problems with family, friends, or school; concerns about the future; and feelings of stress, low self-esteem, anxiety, depression, or loneliness.

We're here to talk with students about issues that are significant for them. We also offer consultation to staff, faculty, and parents who have concerns about a student's well-being. Any discussion regarding a client of the center necessitates a written consent by the student permitting us to release information, including whether the student has been seen at CAPS.

Counseling Center services are provided at no cost. There are, however, limits on the number of sessions that we are able to provide. Follow-up psychiatric services and off-campus referrals for longer term therapy are at the client's expense. The Counseling and Psychological Services office is open weekdays, and there is a professional on call for emergencies during evenings and on weekends.

Health Services

Morewood Gardens E-Tower, 412-268-2157, <http://www.studentaffairs.cmu.edu/healthservices>
Anita Barkin, Director

Student Health Services is staffed by physicians, advanced practice clinicians and registered nurses who provide general medical care, allergy injections, first aid, gynecological care and contraception as well as on-site pharmaceuticals. Examinations by Health Services staff for illness/injury are free of charge; however, fees for prescription medications, laboratory tests, diagnostic procedures and referral to the emergency room or specialists are the student's responsibility. Health Services also has a registered dietician and health educator on staff to assist students in addressing nutrition, drug and alcohol and other healthy lifestyle issues.

Patients are seen by appointment. Walk-in urgent care is provided. Appointments can be made by calling the office. If you have a medical problem or accident that requires immediate attention at night or on the weekend, you should contact University Police at 412-268-2323 for transportation to the emergency room. If you have an urgent problem and would like to speak with the physician on-call, you can do so by calling the Health Services number.

Health Insurance

In addition to providing direct health care, Health Services administers the Student Health Insurance Program. The Student Health insurance plan offers a high level of coverage in a wide network of health care providers and hospitals. It also covers most of the fees for care at Student Health Services. All full-time students are required to carry health insurance and will be assessed a charge for the individual basic mandatory plan offered through the university student health insurance program. The charge will appear on the invoice of the first semester of attendance in the academic cycle. The student is required to take one of the following three actions: (1) enroll in the basic plan as charged; (2) upgrade the benefit plan by enrolling in the enhanced student health insurance options during the open enrollment period; (3) apply for a waiver from the mandatory plan. Questions can be addressed to shinsure@andrew.cmu.edu.

Office of International Education

Warner Hall 301, 412-268-5231, <http://www.cmu.edu/oie>
Lisa Krieg, Director

The Office of International Education (OIE) is committed to supporting, promoting, and celebrating individuals in an intercultural environment. We advocate for and facilitate international and cross cultural experiences, perspectives, and initiatives. OIE is the primary contact for study abroad programs and a key resource on non-immigrant matters for all students and scholars (foreign professors and researchers) who are not United States citizens or permanent residents. OIE encourages both U.S. and foreign students to participate in international programs and events on campus, and we also welcome volunteers to participate and assist with programs sponsored by the office.

Foreign Students and Scholars

Carnegie Mellon hosts 2400 international students and 600 international scholars who come from more than 90 countries. International students make up 47% of the full-time graduate student body and 11% of our full-time undergraduates. OIE is the liaison to the university for all non-immigrant students and scholars. The foreign student and scholar advisors provide many services including: advising on personal, immigration, academic, social and acculturation issues; presenting programs of interest such as international career workshops, tax workshops, and cross-cultural and immigration workshops; supporting international and cultural student groups such as the International Student Union and the International Spouses and Partners Organization; maintaining a foreign student resource library that includes information on cultural adjustment, international education and statistics on foreign students in the United States; posting pertinent information to students through email and our website, and conducting orientation programs.

Study Abroad

Carnegie Mellon students in every major can spend a summer, semester, or year abroad. 250 to 300 students go to all corners of the globe and receive credit for pre-approved study abroad. There is a wide range of funding options. The study abroad office assists students in all stages of the process of going abroad. The advisors promote study abroad, advise students, work with the academic

departments and conduct information sessions, pre-departure orientations and welcome back workshops. For more detailed information about Carnegie Mellon's study abroad program, see the Undergraduate Options section of this catalog.

Office of Orientation and First Year Programs

Morewood Gardens, 412-268-4887, <http://www.studentaffairs.cmu.edu/first-year>
Anne R. Witchner, Assistant Dean of Student Affairs

The Office of Orientation and First Year Programs is responsible for providing vision and leadership for a comprehensive approach to new student orientation and transition programs. The office provides programs, opportunities and services to help students and family members successfully transition to the Carnegie Mellon community.

The office is responsible for program development, marketing and implementation of orientation and transition programs. Areas of concentration include: new student orientation, Family Weekend and special event planning.

Office of Student Activities

University Center 103, 412-268-8704, <http://www.studentaffairs.cmu.edu/StudentActivities/>
Gina Casalegno, Director

The Office of Student Activities complements students' academic experiences by providing services and resources that engage students in creating campus culture through social, cultural, intellectual, spiritual, athletic, recreational, artistic, political, and service opportunities. Our staff is committed to delivering quality advising, resource materials, leadership development opportunities, and administrative support services to impact students' growth and development and enhance the success of each student organization.

Our office partners with students to create a vibrant culture of student life on the Carnegie Mellon campus. Our community boasts over 225 recognized student organizations that are supported by the Student Activities staff team. In addition to serving as individual advisors to many organizations and providing resources, support, and ad hoc advising to all student organizations, our office also coordinates a slate of opportunities to help Carnegie Mellon students get involved in campus life.

To learn more about getting involved on campus, please visit our website where you can find information about recognized student organizations and about upcoming events on campus. If you are interested in forming a new organization, visit our office to learn more about how to get started. We look forward to helping you make your mark on the campus experience at Carnegie Mellon.

Student Development Office

Morewood Gardens, 412-268-9510, <http://www.studentaffairs.cmu.edu/student-development>
John Hannon, Director

The Student Development Office coordinates services, programs and experiences designed to encourage discovery, reflection and self-awareness through the first year residential house experience. A significant portion of this experience focuses on leadership development, social engagement, and community service. To that end, the structure of the house model is designed to promote significant interaction between community members. Students are encouraged to take an active role within their house communities. From improvements to the physical space to a breadth of leadership opportunities, students are strong partners in building safe, positive communities in which each person may share with others their unique strengths and talents. Students drive much of the programming within and between house communities, and student support is critical for community success. Housefellows and student office staff design and implement the residential house experience in Donner, Hamerschlag, Morewood E-Tower, Mudge, Scobell and Stever House. Our commitment to student leadership and personal development in these house settings is also expressed through the advising and support provided to the Student Dormitory Council (SDC) as well as the faculty partnerships that are cultivated through the Big Questions initiative.

Student Life Office

Morewood Gardens, 412-268-2142, <http://www.studentaffairs.cmu.edu/student-life>
Holly Hippensteel, Director

The Student Life Office provides opportunities that emphasize community engagement and social responsibility while actively supporting the personal and professional development of students. To this end, we:

- Coordinate educational initiatives and accountability related to academic and non-academic Community Standards;
- Advise student initiatives including Sexual Assault Advisors, Safewalk, and the Strong Women Strong Girls mentoring program;
- Facilitate programs related to gender and gay/lesbian/bisexual identity including the MOSAIC conference and Pride Month; and
- Advise and support the twenty-four social, Greek-letter organizations and associated governing bodies that comprise the fraternity and sorority community.

Our staff members also serve as housefellows to Doherty House, Woodlawn Apartments, Roselawn Apartments, Margaret Morrison Apartments, Spirit House, Cathedral Mansions, Fairfax Apartments, Shady Oak Apartments, and Veronica as well as the fraternities and sororities.

Housing and Dining Services

Kim Abel, Director
Morewood E-Tower, x8-2139
www.cmu.edu/housing/
www.cmu.edu/dining/

Housing and Dining Services provides a variety of accommodations for Carnegie Mellon students. Living arrangements include traditional single-gender residence halls, coeducational residence halls, suites, apartments, houses and Greek living areas. All first year students, 17 years of age or older, are required to reside in University housing. The Dean of Student Affairs must approve first-year students who wish to be exempt from this requirement and would like to commute from home. Students who will not be 17 before the start of their first semester are asked to contact the Dean of Student Affairs. Transfer student housing is subject to availability and therefore, transfer students are also asked to contact Housing and Dining Services.

University housing is available on campus and in our Oakland Community Apartments. All on-campus residential areas are located in close proximity to academic buildings. The Oakland Community Apartments are located very near the campus and are an approximate 5-10 minute walk to campus. The university's shuttle bus services these areas on a regularly scheduled basis.

Furnishings and Amenities

Housing and Dining Services provides each resident with a bed, a desk and chair, a bookshelf, a dresser and a closet or wardrobe. Each room is also equipped with window coverings and cable TV, and all of our buildings have ethernet or broadband service for fast data connectivity. Items such as pillows, linens, area rugs, telephones, etc., are the student's responsibility.

Room Rates

Room rates include utilities, maintenance, campus and local phone service, a cable TV jack and Ethernet/broadband connection in each room, apartment, or house. Students pay separately for room and public area damages and for toll and long distance telephone usage. (Campus and local calls - within the immediate area - are free. Students pay for all other calls by using their personal authorization code provided by the MobileSphere program.)

Room Types

Residence hall rooms, apartments and houses are available through Housing and Dining Services and are priced according to these broad categories:

Residence hall rooms

- Grouped and priced by occupancy (# of students per room by design) and a classification (standard, prime, suite)
- Singles, doubles, triples, and quads are available
- No in-room cooking facilities
- Classification is primarily based on bathroom privacy, although other criteria may also be involved
- Standard rooms share a large, central bathroom facility
- Prime rooms generally share a private or semi-private bathroom with no more than five students
- Suite-style rooms share a semi-private bathroom, as well as a common living area

Apartments

- Efficiency, one-bedroom and two-bedroom apartments are available
- Grouped and priced by occupancy, location, and number of bedrooms
- In-room cooking facilities

Houses

- Grouped and priced by occupancy and location
- Includes bedrooms, a kitchen, a dining room, a living room, private bath and laundry facilities

Housing Reservations

Returning Student Room Selection (Room Draw)

Each spring returning resident students will have an opportunity to reserve spaces in university housing on a seniority basis through the Room Draw process that takes place in February and March. Returning students most often select apartments and residence hall rooms that offer more flexibility and privacy, features typically created by a kitchen and/or semi-private bathroom facilities.

First-Year Student Room Assignments

Most first-year students are assigned to traditional residence hall rooms where each floor shares a community bathroom. Because these traditional residence hall rooms (standard rooms) support the development of strong community, they provide excellent opportunities for first-year students to develop many friendships on their floor and throughout the building. While every effort is made for first-year students to share a room with other first-year students, a small number of first-year students will sometimes share a room with a returning student. If two first-year students request each other as roommates, their request will usually be honored unless their dates of deposit are too far apart.

Room assignments for first-year students are made in the order in which their original university deposits were processed by the Office of Admission. The Office of Admission provides Housing and Dining Services with the information concerning the date on which each incoming student deposit was processed.

Building and Room Preferences

We give our best effort in fulfilling each student's individual housing preferences, but it is often difficult to accommodate everyone's top choice due to the high demand for housing at Carnegie Mellon. The cost of attendance used in the calculation of a student's eligibility for financial aid includes a housing allowance that is based on a standard double room rate.

Roommate Matching Procedures

A number of factors are taken into account when we make roommate assignments: a preference for a special residential program, specific hall or room type, smoking status, and college and major. Also factored into the equation is personal information about how you intend to utilize your room (social or study purposes), how clean you intend to maintain your room and whether you consider yourself to be a "night" person or a "morning" person. Housing and Dining Services does not, and will not, discriminate in any way in regards to roommate matching. It is important for students to be honest when filling out the housing application as it will eliminate the potential for roommate conflicts.

Housing License Agreement

The Housing License Agreement is a binding document that states the terms and conditions of occupancy by which the student and the university intend to be legally bound including the dates of residence. The agreement is for two full terms, beginning with the fall semester. Housing and Dining Services advises students, parents and guardians to read the agreement thoroughly (a copy is available on our website, www.cmu.edu/housing/). The submission of the Housing License Agreement is an on-line process for both first year and upperclass students. The Housing License Agreement is signed by electronic signature and authenticated by Andrew ID through the WebISO process.

Important Information About Temporary Housing

Because housing is in high demand at Carnegie Mellon, occupancy pressures may dictate that a limited number of first-year students spend anywhere from a few days to a few weeks in temporary housing. Once it is time to relocate to a permanent assignment, Housing and Dining Services will orchestrate and assist in the move.

Housing Charges

The housing room charge is billed in three separate amounts. After charging and crediting the housing deposit, the University bills students for the balance of their academic year housing charges in two separate amounts, one each semester.

Cancellations

Only under very limited circumstances can housing license agreements be cancelled. With the exception of mid-year moves to a fraternity or sorority house as defined in the Greek chapter leases with an approved exemption to the first-year residency requirement the only way a student may initiate a cancellation of his/her housing license agreement is to meet specific criteria related to psychological or medical hardship and complete the appropriate paperwork and provide documentation.

Refunds

During the academic year, if a housing room payment should become refundable, the refund shall be recorded as a credit to the student's account with the University. Refund amounts are calculated on a pro-rated basis for the days remaining in the contractual term after the student completes the entire withdrawal procedure, which includes completion of the Request for Cancellation form and returning the room key to the Office of Housing and Dining Services.

Other Living Arrangements

Students moving into a fraternity or sorority house or leaving university housing (except to participate in an academic program away from the Pittsburgh area) should be aware that their opportunities to move into Carnegie Mellon university housing in the future may be very limited. Students wishing to return to university housing join a wait list for spaces remaining after all returning residents, incoming first-year students and transfer students have been housed.

Community Housing

The Housing and Dining Services provides an off-campus housing registry service. This on-line service maintains up-to-date information on available apartments, houses and rooms in private homes for rent, as well as on students who are looking for roommates. Additional services are also offered that assist customers in finding a new home and provide guidance through all the processes that accompany it.

Since accommodations in the campus residence system are not available to graduate students, Community Housing Services is a good resource for graduate students seeking accommodations in the local area. For more information on our services, please visit our website at <http://www.cmu.edu/housing/CommunityHousing/>

Additional housing information can be found in "The Word", "From the Ground Floor Up, the undergraduate guide to Housing and Dining Services" or at www.housing.cmu.edu

Dining Services

Carnegie Mellon Housing and Dining Services currently features over twenty eating locations in the University Center and in residential and academic buildings across campus. Our cuisine ranges from Asian to Indian to American, from an all-you-care-to-eat meal to a quick sandwich and drink on the go. We have established hours to meet the needs and requirements of the students so that eateries are available from early breakfast to late night snack.

Because of the variety of types of food available on campus and the many dining locations with varying hours per day, Dining Services has been very successful in serving the needs of a dining population with diverse tastes and requirements for international and cultural cuisine, vegetarian and vegan diets, and special food-related medical needs. We employ an executive chef, a registered dietician and other food professionals who work with individual students on nutrition and diet choices.

Casual Dining Program

Casual dining is also a part of the active lives of our students. Vending machines are located in a number of locations throughout campus. From this 24-hour service, students may choose entrees, "Healthy Choice" lunch meats, soup, coffee, assorted beverages and snacks. Many of the machines are enabled for online PlaidCa\$h transactions. Purchases are made by swiping your Carnegie Mellon card through the card reader on each machine, which will access and deduct the cost of the purchase from your PlaidCa\$h account

Dining Plans

Multiple dining plan options are available to students. Dining plans contain a combination of value meals and/or DineXtra A value meal is typically a main entree, at least one side, and a beverage combined to represent a value greater than if all the items were purchased a la carte. DineXtra is a flexible, declining balance account that may be used in all Dining Services locations.

Plaid plans are a selection of meal plans with varying levels of value meals and DineXtra available each week to support student preferences. Plaid plans are also the meal plans all first-year students must choose from to fulfill their meal plan requirement. Upperclass students can buy any of the Plaid Plans or purchase DineXtra through the Plaid Flex Plan. Each semester after the second week of classes, students have the opportunity to change their meal plans to fit their new schedules.

Academic Support Services

Academic Development
Cyert Hall, Suite B5
412-268-6878
www.cmu.edu/academic-development

Academic Development provides a variety of support services geared towards helping students develop the skills, strategies, and behaviors needed to perform as confident, independent, and active learners. These services range from study skills instruction in areas such as textbook reading and lecture note taking to tutoring and review sessions in selected courses. These services are free of charge and available to all Carnegie Mellon students—those who are having difficulties and those who just want to improve their skills.

Following are the services that Academic Development offers:

Peer Tutoring

Peer Tutoring is geared primarily, but not exclusively, toward large introductory courses. It is available from 8:30 – 11:00pm. Sunday – Thursday in various residence halls and on selected weekday afternoons in Cyert B5. This is a walk-in service, and no appointment is necessary. Standing Tutoring appointments are also available upon request.

Study Skills Instruction

Group workshops are held several times each semester, covering topics such as time management, stress management, test taking, and procrastination. Register for workshops or make individual appointments by contacting Academic Development.

Supplemental Instruction (SI)

Supplemental Instruction (SI) is an academic enrichment program that is offered in traditionally difficult courses. SI discussion and

review sessions are facilitated by trained student SI Leaders who have already completed the course and received an A in it.

Designed to supplement – not replace – class lectures and recitations, SI sessions are interactive and collaborative. Students who attend sessions learn to integrate how to learn with what to learn.

SI sessions are usually held twice weekly for one hour; additional sessions are held prior to exams. Attendance at sessions is voluntary.

Study Groups

Organized Study Groups are available in selected courses each term. The Study Groups are limited to six students and are facilitated by a student leader. Come in to the Academic Development office in Cyert Hall, Suite B5 and fill out a Request Form to join a Study Group.

Fast Facts

These pamphlets, which offer tips on a variety of academic success issues, can be picked up from the Academic Development office or can be viewed on the website under "Publications".

Freshmen Fast Facts

This set of five brochures is geared primarily toward freshmen. They cover topics such as working with faculty, optimizing your time, managing coursework and readings, understanding grades, academic integrity, and getting help when you need it.

Teacher Certification

Carnegie Mellon students interested in earning teacher certification can participate in a 5-year program that will allow them to earn their undergraduate degree at Carnegie Mellon and spend one year in an intensive Master of Arts in Teaching (MAT) program at Chatham University to earn the MAT and Pennsylvania Teacher Certification. To make this program possible, interested undergraduate students should plan to cross register at Chatham for 63 units of required courses, using elective spaces in their schedule. Students who will graduate after December 2012 will have slightly different requirements because of changes being made to more adequately meet the requirements of the No Child Left Behind law (mainly related to preparation to work with special education populations and students who speak English as a second language).

Criteria for admission to the MAT program includes: An overall GPA of 3.0, and completion of three pre-professional Praxis exams in Reading, Writing and Mathematics. All candidates for initial certification in Pennsylvania must have earned at least a baccalaureate degree, completed an approved program of teacher education, and passed The Praxis content tests for their certification area. NOTE: Pennsylvania has signed interstate agreements with more than 42 other states, so you are not restricted to teaching in Pennsylvania. Check with the Department of Education in the state where you will live to determine if PA certification will be accepted. To plan early, contact Judith Hallinen, Assistant Vice Provost for Educational Outreach, 8-1498.

Intercultural Communication Center

Peggy Heidish, Director
Office: Warner Hall 308, 412-268-4979
eslhelp@andrew.cmu.edu

The Intercultural Communication Center is a support service offering non-credit classes, workshops, and individual appointments designed to equip nonnative English speakers (international students as well as students who attended high school in the U.S.) with the skills needed to succeed in academic programs at Carnegie Mellon. In addition to developing academic literacy skills such as speaking, reading and writing, students can learn more about the culture and customs of the U.S. classroom. The center offers:

- Writing Clinic: Designed to help students with their academic writing assignments -- this includes support with reading and interpreting source texts
- Seminars and Workshops: such as Presentation Skills, Citing Sources, Improving Scientific Writing and Reading Strategies
- Tutoring: Individual appointments address specific areas such as speaking, listening, grammar and academic fluency.
- Placement Interviews: Evaluate spoken language so that we can suggest appropriate ICC work and give students useful feedback on the strengths and weaknesses of their communication skills.

- The ITA Test: a mandatory screening test for any nonnative English speaker (graduate or undergraduate) who plans to work as a teaching assistant.

Level of English fluency needed for non-Native English speakers - Please see Academic Regulations.

Fellowships

Fellowships and Scholarships Office (FSO)

Stephanie Wallach, Director
Judy Zang, Fellowships Advisor
Julia Spencer, Program Assistant
<http://www.cmu.edu/fso>

Students at Carnegie Mellon are encouraged to apply for a wide variety of national and international fellowships available throughout their undergraduate years and post graduation. These opportunities — some more competitive than others — open up a diverse range of experiences, exposing students to new scholarly communities, to different kinds of research, and/or to service in the public sector. Participation in scholarships, fellowships, and other award opportunities is often an important springboard to future career directions. Many people have heard about the Rhodes Scholarship, the Fulbright Grant and The Harry S. Truman Scholarship, yet there are hundreds of opportunities that may be less well-known but are nonetheless excellent funding sources.

The Fellowships and Scholarships office plays an important role in helping students learn about scholarships that are a good match for their interests. The FSO Staff also works closely with students on their applications to make sure that they are as competitive as possible.

Please visit the FSO Website to learn about the many scholarships and fellowships open to Carnegie Mellon students. The website also contains useful links to other resources for additional information on external educational opportunities.

Honor Societies

Phi Beta Kappa Society

Carnegie Mellon shelters a chapter of the Phi Beta Kappa Society, sponsored by the three colleges (College of Humanities and Social Sciences, Mellon College of Science, and the School of Computer Science) that comprise the University's "arts and sciences" equivalent. The chapter's name is "Upsilon of Pennsylvania," and was formally installed in April of 1995.

Founded in 1776 at the College of William and Mary in Williamsburg, Va., Phi Beta Kappa is the nation's oldest honorary society, with chapters at 276 of the foremost institutions of higher education across the country. Almost all members are elected by the chapters from among candidates for degrees in liberal arts and sciences, usually from the top 10% of the graduating class.

Many notable figures in American History have earned the coveted Phi Beta Kappa key including leaders of the American Revolution, delegates to the Constitutional Convention of 1788, and members of the Continental Congress and the U.S. Congress. Six United States presidents earned the honor as undergraduates and another 10 presidents were elected as alumni or honorary members.

Membership in Phi Beta Kappa key has become a universally recognized mark of academic achievement in the liberal arts and sciences. The key's venerable pointing finger proclaims for all to see the wearer's commitment to Phi Beta Kappa's ancient principles (represented in the three stars) — friendship, morality and learning

The society's name is formed by the first letters of the phrase Philosophia Biou Kybernetes, Philosophy (wisdom) is the Guide of Life. In line with the conviction that the test of education lies not in what people know but in what they are, the objectives of humane learning encouraged by Phi Beta Kappa include not merely knowledge but also intellectual honesty and tolerance, a broad range of intellectual interests and understanding.

The Carnegie Mellon chapter is active in sponsoring visiting speakers, on-campus roundtables that focus on current issues, community service activities, scholarship opportunities, student research involvement, and the like.

The Honor Society of Phi Kappa Phi

The Honor Society of Phi Kappa Phi has been an important presence on campus since 1933. Phi Kappa Phi, a national honor society that began in 1897 at the University of Maine, takes its name from the

initial letters of its adopted motto, *Philosophia Krateito Photon*, "Let the love of wisdom rule humanity." Phi Kappa Phi recognizes and honors persons of good character who have excelled in scholarship, in all fields of study. Members are nominated by their department or their school or college and then invited to join the society. To be eligible, seniors must be in the top ten (10) percent of their class and juniors in the upper seven and one-half (7.5) percent of their class at the time of invitation. Graduate students, alumni, faculty and staff are also eligible for nomination. The chapter inducts new members once a year, each spring, and provides information to its members on all sorts of opportunities, including study abroad, internships, and graduate fellowships, recognition and awards.

Undergraduate Research Office

Stephanie Wallach, Director
Jennifer Weidenhof, Program Coordinator
www.cmu.edu/uro

What is the Undergraduate Research Office (URO) at Carnegie Mellon? Conducting Research as an undergraduate is a terrific way to get to know faculty members, explore an area of interest in depth, turn classroom theory into practical hands-on experience, get a feel for graduate school, and have some fun at the same time! The Undergraduate Research Office supports students conducting independent research and creative projects in every field at the university.

All undergraduates conducting research with a faculty advisor are eligible to participate in Undergraduate Research Office programs. The term "research" is defined broadly as "research, scholarly, or artistic activities that lead to the production of new knowledge; to increased problem solving capabilities, including design and analysis; to original critical or historical theory and interpretation; or to the production of art or artistic performance." Students from all fields and at all levels are encouraged to participate in the research process at least once, and hopefully many times, in their undergraduate careers.

Advising and Information Services

The Director of the Undergraduate Research Office is available to discuss project ideas, locate possible funding sources, and generally facilitate the research process. The Office also maintains a website containing announcements of research opportunities, summer programs, fellowships, seminars and conferences.

Small Undergraduate Research Grants (SURG)

Undergraduates in good academic standing are eligible to apply for a Small Undergraduate Research Grant (SURG). Awards are made twice each year based on submitted project proposals. A panel of faculty and administrators from each of the colleges serves on the selection committee and will generally consider requests up to \$500 for individual student projects or \$1000 for a group project. Grants may be used to purchase supplies and materials, rent time on laboratory equipment, pay subjects in an experiment, or even travel to another city to collect data. Deadlines are October for the Spring grant period and in March for the Summer and Fall grant periods.

Summer Undergraduate Research Fellowship (SURF)

Also known as SURF, these fellowships are designed to allow students a 10-week summer of supported research at Carnegie Mellon in close collaboration with a faculty advisor. Students receive a fellowship of \$3,500 as a stipend to cover any of their expenses. The deadline for submission of proposals coincides with the regular SURG deadline in March.

Undergraduate Research Symposium: Meeting of the Minds

The undergraduate research symposium, known as "Meeting of the Minds," is an annual event that brings our campus together to celebrate the diverse, creative, and ground-breaking research that takes place among undergraduates. Students share their research findings through poster, oral, and artistic presentations. Many Participate in award competitions sponsored by various corporations, individuals, and organizations.

Presentation Awards

Students whose work has been accepted for presentation at an academic conference are eligible to apply for a Presentation Award. These awards, up to \$250, help defray costs of conference registration, transportation, and accommodation.

Intel First Year Research Experience (IFYRE)

First- and second-year students in semiconductor research and information technology fields are eligible to join faculty labs — depending on the needs of the faculty and qualifications of the student — to get an early taste of the excitement and benefits of undergraduate research.

THOUGHT

THOUGHT is Carnegie Mellon's undergraduate research journal — a student-run journal where students can publish the results of their research findings. Our undergraduate design and professional writing majors can join computer scientists, engineers, and history, business, and biology majors — just to name a few — to make this an exciting and growing part of our URO programs.

Undergraduate Research Office
www.cmu.edu/uro sw4s@andrew.cmu.edu 412.268.5702

University Center

Carnegie Mellon's University Center is the first building of its kind on our campus. A central gathering place for all members of the university community, the University Center is the hub of Carnegie Mellon's social, athletic, recreational and religious life.

- Play basketball, volleyball and badminton
- Play racquetball or squash on one of five courts
- Swim in the eight-lane lap pool or dive into the diving well
- Work out on new weight machines, rowers, stair climbers, ellipticals, and treadmills
- Take a group exercise class including yoga, indoor cycling, Pilates, and Zumba. Check the website www.cmu.edu/athletics/facilities/university-center.html for further information.

The locker rooms include showers, whirlpools, and steam rooms.

Eating at the University Center

We've brought in several outside vendors to offer a variety of dining options:

- Bento Bowl
- East Street Deli
- Entropy (A convenience store)
- Evgefstos
- Kosher Korner
- On-the-Go
- Schatz Dining Room
- Showcase Salads
- Si Senior
- Skibo Cafe
- Sushi Two

Shopping at the University Center

Carnegie Mellon's retail stores are in the University Center. These include the Art Supply Store and the University Shoppe, a multi-level retail facility for art/engineering supplies and tools, books, textbooks, clothing, memorabilia and the computer store.

The building houses student organization offices, activity space and the Scotland Yard gameroom. The gameroom includes pool tables, foosball, ping pong and shuffle board. The building also includes the Student Activity staff offices, a gallery/exhibit area, webstations and printer, a multi-denominational chapel, a prayer room, the University Post Office, a recycling room, FedEx Kinkos, ATMs, PNC branch bank, the Career Center and an alumni lounge, which is open to all members of the university community.

Undergraduate Academic Advising

Carnegie Mellon recognizes the vital role of academic advising in undergraduate education. The university assigns an academic advisor to each student, and makes certain that all advisors have clear, timely, and accurate information concerning programs, policies, procedures, and resources. In addition to having assigned academic advisors, students often develop relationships with faculty and staff members who serve as academic mentors.

Institutional Statement on Advising

Academic advising is integral to the educational mission of Carnegie Mellon. Advising is an intentional process, grounded in teaching and learning, and provides each student with guidance for developing and achieving meaningful educational, professional, and personal goals. Successful advising at Carnegie Mellon depends upon a shared understanding of, and commitment to, the advising process, by students, advisors, and the university. Academic advisors engage students in learning, promote students' academic success, and foster students' personal, ethical, and intellectual growth, all of which will carry into their roles as citizens and lifelong learners.

The Student's Role in Academic Advising

Seeking advice is an important part of how students begin to make decisions about their academic and professional futures. Each major and department has an advising system which may be different from one another. It is important that students find out early from their first year advisor how the advising system for all their four years at Carnegie Mellon works.

Students are responsible for: understanding the importance of their relationships with advisors; seeking out advisors, contacts, and information on a regular basis; knowing the requirements of their individual degree programs; and taking final responsibility for making their own decisions based on the best information and advice available. The Carnegie Mellon Advising Resource Center (CMARC) is an additional place for students to obtain information and general advice.

The Advisor's Role

To achieve the goals of academic advising at Carnegie Mellon, advisors, along with their advising programs, are responsible for: being knowledgeable of, and communicating, the requirements of the academic programs in which they advise; monitoring students' progress towards degree completion; being available to meet with students on a regular basis; assisting students in finding the appropriate institutional and community resources; involving students in the academic and career planning process and the exploration of options and resources; and engaging in developmental activities to stay informed of issues that impact student success.

University Police

Director: Lieutenant John Race, acting chief
Office: 300 South Craig Street, Room 199
Public entrance on Filmore Place
www.cmu.edu/police

The University Police Department consists of 24 sworn Police Officers, 37 Security Guards, and five Communications Dispatchers. University Police provides campus buildings and grounds patrol, emergency medical transport, personal escorts, and other services to increase the safety and well being of persons and property in the university community. Officers patrol the campus continuously 24 hours a day, seven days a week on foot, on bicycle and in vehicles and remain in constant radio contact so that they can respond rapidly in the event of an emergency. Direct line emergency telephones to the University Police communications center are located both inside and outside of buildings at 53 locations around the campus.

All crimes that occur on campus should be reported immediately to University Police to ensure that appropriate action is taken. Crime occurring on campus can be reported in person, or by calling the University Police emergency number, (412) 268-2323 or x8-2323, any time of the day or night. All other non-emergency inquiries should be made by calling the non-emergency number (412) 268-6232 or x86232.

University Police operates an Operation Campus Watch program to increase the awareness of the entire community at Carnegie Mellon. The concept of Operation Campus Watch includes two simple aims:

1. The sharing of crime information by University Police.
2. The involvement of the entire community in reporting suspicious activity or actual crime.

Additional information on Operation Campus Watch is available at the University Police Office located in Room 199, 300 South Craig Street or by calling the non-emergency number, (412) 268-6232.

All emergencies on campus, including fire and medical, should be reported immediately to University Police.

Students are responsible for their personal property as well as the property of groups to which they belong. Insurance against loss, theft, or damage to such property occurring in the residence hall or elsewhere on campus must be arranged for by students or their parents through an insurance agent.

University Police makes available on the world wide web a wide range of information about the university's security practices. Descriptions of crime prevention programs, alcohol and drug, sexual assault policies, and statistics about the number and type of crimes committed on campus during the preceding three years can be found at www.cmu.edu/police, click on "Campus Security Reports."

University Libraries

Dean: Gloriana St. Clair
Office: Hunt Library / 412-268-2447 / gstclair@andrew.cmu.edu
www.library.cmu.edu

Facilities and Services

The University Libraries' collections support teaching and research at Carnegie Mellon. The collections for various disciplines are housed in three libraries: the Engineering and Science Library (engineering, mathematics, physics, computer science and robotics), Hunt Library (humanities, fine arts, social sciences and business) and the Mellon Institute Library (chemistry and biology). An off-site storage facility holds low-circulating materials, which are available at your request via the library catalog. Interactive access to library resources is supported by the University Libraries' home page at www.library.cmu.edu/.

Reference service helps you to select resources and find the information you need. If you need materials that we do not own, interlibrary loan service will help you to obtain them. Circulation service helps you to borrow and renew materials, and to use course reserves (items that faculty have set aside in the library for their classes to use).

The University Libraries also house several unique collections, including the Architecture Archives (regional architects and architecture), the H. John Heinz III Archives, the Allen Newell Collection, the Clifford Shull Collection, the Herbert Simon Collection, the Joseph Traub Collection, and the University Archives (history of the university). The Fine and Rare Books collection includes exceptional materials in literature, the arts, the history of science and other subjects. The Posner Center, located between the College of Fine Arts and Tepper School of Business, houses the Posner Family Collection of rare books and artifacts.

Library Catalog and Other Online Access

The library catalog (Cameo) provides access to all of the Carnegie Mellon library collections. Use Cameo to find out where materials are located in libraries on campus, and whether they are checked out, on reserve, or available to be borrowed. Cameo's self service features are also handy. For example, click "User Self Service" and "Library Account Information" to see a list of the items that you have checked out. Click "User Self Service" and "Renew Items" to extend your loans and avoid overdue fines.

You can access many resources and services from the University Libraries' home page. For instance:

- "Databases" index and describe specific information located in various sources. Some databases include full-text.
- "Ask A Librarian" (chat, email or phone) is an interactive reference service staffed by Carnegie Mellon librarians.
- "Research Help" pages direct you to key resources in your subject area, including the Carnegie Mellon librarian who is a subject specialist for your field.

From our home page, you can also use the online catalogs for the University of Pittsburgh Library System, The Carnegie Library of

Pittsburgh, and other local libraries. We are partners with Pitt and The Carnegie; you can get library cards and borrow directly from these nearby libraries.

Instruction and Help

Get acquainted with the collections and services that support your school and subject area. Take advantage of library orientations and other library instruction classes that will help you become adept at using information resources. Being able to select good sources, access information efficiently, and evaluate results are skills that you will use throughout your academic and professional career.

Reference desks at the Engineering and Science Library, Hunt Library, Mellon Institute Library, and in Arts and Special Collections (at Hunt Library) are staffed weekdays, evenings, and on weekends. Besides helping you when you are in the library, reference staff also can show you how to use online resources effectively from outside the library.

If you need specialized reference help, contact the librarian for your subject area. Librarians work directly with the faculty and students in each school, department and institute at Carnegie Mellon to build useful collections and assist research.

Undergraduate Jobs

The University Libraries hire many undergraduate students each year, primarily through state and federal work/study programs. Working part-time in the library gives you the unique opportunity to learn and practice skills that will contribute to academic success while you earn some spending money. If this sounds interesting to you, check out the library job opportunities for student assistants at www.library.cmu.edu and apply.

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Undergraduate Options

Additional Majors/Dual Degrees

Students interested in pursuing more than one area of study are encouraged to consider an additional major or dual degree. Students who complete an additional major will earn a single degree in two areas. Generally, it is possible to fulfill the requirements of both majors in four years by taking the course requirements of the second major in the elective spaces allowed by the first major. Students in Carnegie Institute of Technology may elect to double major in Engineering and Public Policy or Biomedical and Health Engineering, which are offered only as an additional major. Human Computer Interaction is also offered only as an additional major.

Dual Degree programs allow students to earn two degrees. Students who are interested in an additional major or dual degree are encouraged to review the specific possibilities with the relevant academic advisor.

Five-Year Bachelor's/Master's Programs

Qualified undergraduates may apply to one of several programs to earn their bachelor's and master's degrees in five years. For further details about these programs, please refer to the appropriate college or departmental section(s).

Carnegie Institute of Technology

The five-year Integrated Master's/Bachelor's programs offered by the Departments of Electrical and Computer Engineering and Civil and Environmental Engineering offers students superior technical preparation for careers in industry. The Departments of Chemical Engineering and Mechanical Engineering also offer fifth year/ Accelerated Masters programs. The Department of Materials Science and Engineering offers a cooperative Industrial Internship Option in which students alternate coursework with practical experience in industry. Admission is highly competitive and leads to a Master of Science degree.

College of Humanities and Social Sciences

The Department of Philosophy offers a bachelor's/master's degree option: the Bachelor's/Master's degree in Logic and Computation. The M.A. in Teaching English to Speakers of Other Languages (TOESL) is a fifth year master's option for Modern Language students who are concentrating in English as a Second Language. Also, the department of English offers an accelerated program for undergraduates to obtain a Master of Arts in Professional Writing.

H. John Heinz III School of Public Policy and Management

The Heinz School's Accelerated Masters program allows qualified undergraduate students to earn a prestigious Master of Science degree in Public Policy and Management. For students in the College of Fine Arts or the Bachelor of Humanities and Arts degree program who are interested in careers in arts management, the program leads to a Master of Arts Management degree.

Mellon College of Science

The Honors Programs in the Departments of Chemistry and Mathematics are demanding, accelerated programs that give highly qualified students the opportunity to earn their bachelor's and master's degrees in just four years. Admission is by invitation only.

Tepper School of Business 3-2 Program

Students who are interested in business management may wish to consider the Tepper School of Business 3-2 program. Qualified undergraduate students may earn their master's degree in Industrial Administration in addition to their bachelor's degree. For students interested in earning a Master of Science in Quantitative Economics degree, TSB offers an accelerated B.S./M.S. program in Economics.

Health Professions Program

Director: Amy L. Burkert, Ph.D.

Office: Doherty Hall 1319

The Health Professions Program (HPP) at Carnegie Mellon University is an advising and resource center for all university students and alumni who are interested in one or more aspects of the health professions. This program complements a student's curricular advising and is meant to help students explore their interests, prepare for graduate programs in the health professions, and facilitate their application process. Students can enroll in the program at any time during their academic career, but the importance of early planning is communicated to interested first-year students. Once enrolled, students meet regularly with the director to discuss course requirements, medical exposure opportunities, and other aspects of preparing to be a competitive candidate.

Students in the HPP span all colleges of the university and have many diverse career interests including medicine, dentistry, optometry, biomedical research, medical physics, rehabilitation engineering, medical informatics, and health policy. Although the majority pursue a primary major in the Mellon College of Science, other highly represented disciplines include engineering and the social sciences.

Regardless of a student's major, the basic course requirements outlined below must be completed prior to medical school matriculation, and most should be taken before the student takes the Medical College Admissions Test (MCAT) that is normally taken in spring of the junior year:

1. One year of general biology with lab.

This is typically fulfilled by the following Carnegie Mellon courses:

03-121	Modern Biology
03-230	Introduction to Mammalian Physiology
03-124	Modern Biology Lab
or	
03-343	Experimental Genetics and Molecular Biology

2. One year of general chemistry with lab.

This is typically fulfilled by the following Carnegie Mellon courses:

09-105	Introduction to Modern Chemistry
09-106	Modern Chemistry II
09-221	Lab I: Introduction to Chemical Analysis

3. One year of organic chemistry with lab.

This is typically fulfilled by the following Carnegie Mellon courses:

09-217	Organic Chemistry I
09-218	Organic Chemistry II
09-222	Lab II: Organic Synthesis and Analysis

4. One year of physics with lab.

This is typically fulfilled by the following Carnegie Mellon courses:

33-106/111	Physics I (for science or engineering students)
33-106/112	Physics II (for science or engineering students)
33-100	Basic Experimental Physics

5. One year of English.

This is typically fulfilled by the following Carnegie Mellon courses:

76-101	Interpretation and Argument
76-xxx	English course of the student's choice, typically 200-level or higher

In addition to these general course requirements, recommended coursework includes calculus, biochemistry, statistics, behavioral sciences, ethics, and languages. Interdisciplinary studies are also strongly encouraged, and many students design an undergraduate curriculum that incorporates majors and/or minors in both the natural and social sciences. One interesting interdisciplinary minor offered is the Minor in Health Care Policy and Management, which broadens awareness of the health care field from social, economic, historical, and policy perspectives. See page 287 for the details of this minor.

Undergraduate research is a hallmark of the educational experience at Carnegie Mellon in many disciplines. Whether in the psychology lab studying the impact of breast cancer diagnosis on family social dynamics, in the NMR lab imaging metabolic function in the heart or brain, or in the surgery suite testing robotic devices, our students have made significant achievements in research, well beyond the more traditional guided experiments.

Our university policy is to train students to be first class scientists, engineers, artists, writers, managers, or whatever their passion may be. We do not train students to be “pre-meds,” but if they choose to use their talents in a health profession, we offer many services to help them obtain their life goals. Regular advising, application workshops, health issue seminars and symposia, community outreach activities, and preceptorship/ internship experiences are all part of our programming. The student pre-health organizations on campus, the Doctors of Carnegie (DOCs) and the Minority Association of Premedical Students (MAPS), together with the Health Professions Program, provide students with many opportunities to learn, explore, and prepare for their chosen area of professional interest.

The Health Professions Program has been successful in helping students to define, prepare for, and obtain their professional goals. Our students are regularly accepted at top-level medical and graduate programs, and our alumni continue to serve as outstanding ambassadors of Carnegie Mellon and the training and experience they received here.

Minors

The following minors offer a secondary focus to the student's major area of study. Unless otherwise indicated, minors are generally open to all university students.

Intercollege:

- Arts in Society (sponsored by the Center for Arts in Society)
- Health Care Policy and Management (sponsored by the College of Humanities and Social Sciences, the H. John Heinz III School of Public Policy and Management, and Mellon College of Science)

Carnegie Institute of Technology:

Biomedical Engineering
Engineering Studies
Robotics Technology and Policy

Designated Minors (open only to CIT students):

Automation and Control
Biomedical Engineering
Colloids, Polymers and Surfaces Technology
Data Storage Systems Technology
Electronic Materials
Engineering Design
Environmental Engineering
Manufacturing Engineering
Materials Science and Engineering
Mechanical Behavior of Materials
Robotics

The College of Fine Arts:

Accompanying (open only to students majoring in Music)
Architecture
Architectural History (available also to B.Arch. candidates)
Architectural Representation and Visualization
Architectural Technology
Art
Building Science (open only to B. Arch. candidates)
Communication Design
Conducting (open only to students majoring in Music)
Drama
History of the Arts
Industrial Design
Jazz Performance
Jazz Performance (for students majoring in Music)
Music

Music Education (for students majoring in Music)

Music Performance
Music Technology
Music Theory
Photography, Film and Digital Imaging

The College of Humanities and Social Sciences:

African and African American Studies
Chinese
Decision Science
English
Environmental Policy
Ethics
European Studies
Film and Media Studies
French and Francophone Studies
Gender Studies
German
Hispanic Studies
History
International Relations
Japanese
Linguistics
Logic and Computation
Minority Studies
Multimedia Production
Philosophy
Policy and Management
Political Science
Psychology
Religious Studies
Russian Studies
Science, Technology and Society
Second Language Acquisition
Sociology
Statistics
Student Defined

Tepper School of Business:

Business Administration Management (for Students in CFA)

Mellon College of Science:

Biological Sciences
Chemistry
Discrete Mathematics and Logic
Environmental Science
Mathematical Science
Physics
Scientific Computing
Secondary Education and Teacher Certification

School of Computer Science:

Computer Science

Pre-Law Advising Program

Director: Joseph Devine, Associate Dean for Undergraduate Studies, H&SS

Office: H&SS Dean's Office, Baker Hall 154

“Law School” is an objective that students frequently mention when asked about post-baccalaureate plans. It seems in its brevity to be a simple enough answer, but in reality it masks a host of complex and momentous personal decisions and strategic tasks.

First and foremost, seeking entry into law school implies an informed decision about the rigors of law school and the realities of professional life as an attorney, as well as a strong and mature commitment to achieving these objectives at significant cost and investment (financial, personal, and intellectual). Second, it implies an understanding of the prolonged sequence of steps involved in the process of selecting law schools to which to apply, actually applying, ultimately selecting a school to attend, financing a law school education, and succeeding in law school. Finally, it implies an understanding of this as one of many alternatives that should be conscientiously and intelligently considered before a choice is made that will so significantly influence the course of one's personal and professional life.

To address these needs, the University offers a Pre-Law Advising Program for students and alumni/ae who are contemplating or actively seeking to enter law school and careers in the law. The program consists of a range of support services, coordinated centrally, designed to assist these groups in engaging the complex questions associated with decisions about law school and careers

in the law, and in successfully negotiating the sequence of tasks associated with selecting, applying and gaining admission to the best law schools possible.

The emphases of this program are:

1. early identification of "pre-law" candidates;
2. stimulation at early stages and throughout this process to consider the essential questions of personal suitability for law school and professional life as an attorney, and also to engage meaningful substantive issues rooted in the law that illustrate the intellectual complexities of our legal system and the corresponding intellectual acumen needed to enter and thrive in this profession;
3. timely direction in designing and executing a well-planned law school research, selection and application strategy;
4. gathering and using accurate data on university alumni entering law school and the legal profession.

The program proper consists of several components, organized and made available as an ongoing service to all students in, and graduates of, the University. These components include periodic workshops and seminars, a Pre-Law Handbook, a pre-law library, and linkage through the Program Director with law school admissions offices, the Law School Admissions Services, and associations (both regional and national) of pre-law advisors. The program also works with the student Pre-law Society and Undergraduate Student Mock Trial Association.

Two "early admission" options are available to Carnegie Mellon undergraduates interested in either of Pittsburgh's two law schools: the Duquesne University School of Law, and the University of Pittsburgh School of Law. Requirements and procedures vary for each option. Interested students should meet with the University pre-law advisor before the end of their junior year.

Study Abroad

Carnegie Mellon students from every major can study in any part of the world for a semester, year or summer. Short-term programs during spring and winter break are also possible. A well planned study abroad program will allow a student to receive credit for study abroad and graduate on time. Most students study abroad during their junior year; however, a growing number of students are studying abroad during their sophomore and senior years.

The study abroad advising staff offers general information sessions as well as individual advising appointments to assist students in all stages of the study abroad process. The Office of International Education (OIE) has a large in-house library as well as useful web links to help students find the most appropriate study abroad program. In addition, OIE offers orientations to help with personal, academic and acculturation issues, before and after a study abroad experience.

Carnegie Mellon offers students a variety of payment schemes for study abroad to allow students to study abroad regardless of financial need. There are three categories of programs: Exchange Programs, Sponsored Programs, and External Programs. A description of each program follows. More detailed information can be found at www.cmu.edu/studyabroad.

Exchange Programs

Students who participate in exchange programs pay Carnegie Mellon tuition and receive their regular financial aid package. Students are responsible for room, board, travel and miscellaneous expenses.

University Exchanges

Carnegie Mellon University has university-wide exchange programs with institutions located in Australia, Chile, Hong Kong, Israel, Japan, Mexico, Qatar, Singapore, and Switzerland.

Departmental Exchanges

Architecture, Art, Chemical Engineering, Design, Drama, Electrical and Computer Engineering, English, Heinz School, Information Systems, Materials Science and Engineering, Modern Languages, Computer Science and Business offer departmental exchange programs. Students should contact their department or the study abroad website for additional information.

Sponsored Programs

The university has designated a few study abroad programs administered by other organizations or universities as sponsored programs. To participate in these programs students pay a university fee equivalent to current tuition, room and board, and retain their eligibility for all financial aid. Carnegie Mellon in turn pays the program costs to the study abroad sponsor. Where applicable, funds are distributed to the student for room, board, travel, and personal expenses.

Currently Carnegie Mellon has 38 sponsored programs available around the world. A full list can be found at www.cmu.edu/studyabroad or in consultation with a study abroad advisor.

External Programs

Students may also participate in a program sponsored by another university or study abroad organization if the student's home department approves the program and its course offerings. Students will pay the other organization or institution directly. Students who receive institutional aid from Carnegie Mellon will not be eligible for this aid while they are abroad. However, students with state and federal aid will still qualify. Students can learn more about external program options during study abroad advising appointments and by exploring the study abroad website and library.

University Student-Defined Major

Carnegie Mellon offers the opportunity for undergraduate students to pursue a University Student-Defined Major. (There are also opportunities to pursue a Student-Defined Major in some of the colleges [see relevant college section of the catalog]). For information and advice, interested students are encouraged to speak to the Associate Dean (sic) of their current home college or the college most relevant to the proposed course of study.

The requirements for successful completion of a University Student-Defined Major include a student proposal approved by an advisor, relevant college(s), and the Provost, and successful completion of the approved course of study. In brief:

- A student interested in pursuing a university student-defined major must develop a proposal which outlines an intellectually coherent area of study (with degree title) and a plan of study (courses to be taken, pedagogical rationale, proposed schedule). The proposal should include an explanation of why it is not appropriate or possible to pursue such a program through the curriculum of any one of the colleges. It should outline a program of study for both general education (for example, the core requirements of one of the most relevant colleges or equivalent general education plan) and major requirements. The proposal should designate one of the participating colleges as de facto "home college" for tracking and verification purposes.
- The student's proposal must be approved by a faculty advisor within a college who takes pedagogical responsibility for the program, by the de facto "home college" and by any other colleges involved in granting the degree. The signed proposal will be submitted to the Provost's office for a final review and approval.
- Once approved by the faculty advisor, colleges, and the Provost's office, the student's major will be administered by the advisor and his/her progress tracked by the Dean's office of the "home college." The "home college" will be responsible for monitoring the student's progress and reminding any collateral colleges of the approval of the student-defined major so that these colleges may insure the student's ability to enroll in the necessary courses. Upon successful completion of the course of study, the "home college" will be responsible for contacting all the relevant colleges and verifying the completion of the degree. Unless there are sufficient numbers of university student-defined majors in any graduation year, upon consultation with the "home college," students may choose to receive the diploma in the most relevant department's ceremony.

University Summer Sessions

The campus is in full operation during the summer, populated by students and faculty from a variety of programs. The university continues to have outstanding, innovative educational programs extending beyond regular involvement with its degree candidates. Three sessions of summer school are held for college students who wish to make up or advance their degree program studies. Every service and support organization is available to summer students: Computing Services, the Student Health Center, the Counseling Center, the University Libraries, the Office of Admission, the Career Center, Student Activities, etc.

Session One: mid-May to early July

Session All: mid-May to mid-August

Session Two: early July to mid-August

The three summer sessions of credit course work are designed to meet the needs of currently enrolled college students (not exclusively Carnegie Mellon students) as they complement or supplement various college programs. The university offers a wide range of courses in the Carnegie Institute of Technology (CIT), College of Fine Arts (CFA), College of Humanities and Social Sciences (H&SS), the Mellon College of Science (MCS), the School of Computer Science (SCS), and the Undergraduate Business Program in the Tepper School of Business (TSB).

Undergraduates have the opportunity to earn advanced credit, remove deficiencies, and regularize their schedules pursued during the academic year; graduates may work toward master's and doctor's degrees, and professional people are encouraged to increase their knowledge and skills. There are two summer sessions, both seven weeks in duration. Special programs and graduate work may cover other periods of time.

Carnegie Mellon reserves the right to withdraw any course not justified by the number of applicants and to make changes in scheduling when necessary and advisable.

Requests for further information should be addressed to:

The HUB
Enrollment Services
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213-3890
(412) 268-8186
FAX: (412) 268-8084

Department of Athletics & Physical Education

Susan Bassett, Director of Athletics
Office: 204 Gymnasium

Intercollegiate Athletics

Carnegie Mellon emphasizes excellence in its intercollegiate athletic programs as well as in its classrooms. The University strongly believes that academic and athletic excellence can successfully coexist. It also believes that intercollegiate athletics are important in student life and can become a key part of the educational experience. Professional and social endeavors after graduation also benefit from university experiences as a student-athlete.

Carnegie Mellon sports teams have competed intercollegiately since the early 1900s. In the past 15 years, the program has experienced extensive success. The Tartans have won 81 conference championships and competed in over 108 national championships since 1976. This success has been achieved while meeting all of the academic requirements of demanding programs and without athletic scholarships.

In 1986, Carnegie Mellon became a charter member of the University Athletic Association (UAA), a nine-team league of similar institutions with regard to academic and athletic programs. The UAA, a national association which geographically reaches as far north as Massachusetts, as far south as Atlanta and as far west as St. Louis and Chicago, sponsors intercollegiate competition in 24 sports including 12 for men and 12 for women. UAA members include Brandeis University, Case Western Reserve University, Carnegie Mellon University, Emory University, New York University, the University of Chicago, the University of Rochester and Washington University in St. Louis.

Carnegie Mellon, like the other seven UAA members, is a member of the National Collegiate Athletic Association (NCAA). Its intercollegiate teams compete on the Division III level, which prohibits athletic scholarships and operates under the true meaning of amateurism. Student-athletes who play at the varsity level are students first and athletes second. All students, both athletes and non-athletes, are treated equally with regard to admission and financial aid policies. Carnegie Mellon fully supports a policy of equity in resources and opportunities for women and men.

The university fields competitive teams in 17 sports. The Tartans compete in football, men's and women's soccer, men's and women's cross-country, men's and women's tennis, women's volleyball, men's and women's basketball, men's and women's swimming, men's and women's indoor and outdoor track and field, and golf.

Carnegie Mellon's intercollegiate program has consistently produced winners. The Tartans' football team has won 15 conference championships, has a string of 33 consecutive winning seasons, and has appeared in the NCAA Division III Championship playoffs six times. In 1979, Carnegie Mellon was awarded the Lambert Trophy as the best small college team in the northeast. The men's cross country won the conference championship in 2005 going on and placing 8th at nationals that same season. The team also has had a 12th and 9th place finish at nationals. The women's cross country won the 1998 conference and went on to place 4th nationally.

A freshman computer science major on the men's tennis team won the NCAA National singles title in 2000 and Carnegie Mellon's top doubles team also was selected to play in the nationals. The men's program garnered their highest team ranking ever in 2006 at 11th nationally. The women's tennis team has recently produced national ranked players in the NCAA competition and in 2005 had a sophomore claim the ITA National Small College Championship while earning the James O' Hara Sargent Sportsmanship Award. Both men's and women's swimming and track and field teams annually qualify a number of athletes for the national championships. Swimming recently has produced a national champion and the men's track and field team has won back-to-back conference championships.

To provide excellence in the athletic program, the department employs full-time coaches in all varsity sports. Intercollegiate competition begins with the first football and soccer games in early September and ends with the UAA track and field, golf and tennis championships in late April. Students with athletic skills in any of the above mentioned sports are welcome to become members of the team. Participation is open to all students. Inquiries may be directed to the appropriate coach at the:

Department of Athletics, Skibo Gymnasium, Carnegie Mellon University, Pittsburgh, PA 15213 (412) 268-8551

Recreation

In addition to providing for its more formal programs and teams, Carnegie Mellon's athletic facilities are available for use by individual students on an extensive seven-day per week schedule. Hours for recreational use of all facilities are subject to change during varsity sports seasons.

The Skibo Gymnasium, which has facilities for basketball, volleyball, badminton, weight lifting, state of the art cardio equipment, is open Monday through Friday, as well as weekends. Located within the University Center are facilities for squash, basketball, racquetball, volleyball, badminton, a diving pool and a large swimming pool for lap swim, cardio machines like treadmills, Expresso Bike EFX, steppers, and other state of the art machines, Cybex machines, dumbbells, a sauna and a whirlpool. Gesling Stadium provides soccer, football and track facilities. Tennis courts, located between the University Center and Margaret Morrison, are lighted for night play. During the school year they are open for use by students, faculty and staff.

These facilities are available to any student, faculty or staff person with a valid Carnegie Mellon ID. For hours, please contact the Athletic Office at (412) 268-1236.

Physical Education

The Department of Physical Education provides an elective program with an emphasis on personal fitness and lifetime recreation, thus preparing students for physical activity after the college years. Most classes are offered on a mini-course system with each class running seven weeks in length.

This program of more than 30 courses is designed for all students, from the beginner to those students who have already developed some skill. Courses include personal fitness, racquetball, tennis, golf, weight training, karate, aerobic fitness, and yoga. Instruction is also provided in several team sports. Carnegie Mellon also provides courses for American Red Cross certification in the four levels of swimming (beginners, intermediate, swimmers, and life guarding), and First Aid and Cardiopulmonary Resuscitation (CPR).

Intramurals

For those who seek another level of competition or just like to participate and have fun, the Intramural Program provides recreation and relaxation for all students, faculty and staff, regardless of the degree of their natural athletic skills. The university prides itself on an intramural program which annually involves some 6,000 students. Men and women, both graduate and undergraduate, compete in one or more of over 40 indoor and outdoor sports, ranging from flag football and basketball to table tennis, water polo, and ultimate frisbee.

The Intramural Department is under staff direction, but four student-run organizations (the Intramural Board, the Managers' Club, the Women's Representatives and the Officials' Club) govern the events.

Through participation in this program, students are able to keep physically fit, put to good use various learned skills, and develop leadership, team play and sportsmanship. Intramural activities, like all sports endeavors, contribute to physical development, good health, and a sound state of mind, while providing keen competition and team spirit. In addition, intramurals possess an inherent flexibility that allows for a limited commitment of time in light of academic priorities. The intramural program permits students from all departments to meet and socialize on an informal basis.

The following is a listing of the intramural sports offered by season:

Fall	Spring
Flag Football	Basketball
Tennis	Table Tennis-Singles
Golf	Faculty/Grad. Volleyball
Co-Rec Volleyball	Pinochle
Cross-Country	Individual Call Pool
Water Polo	Swimming
Chess	Indoor Soccer
Soccer	Softball
Volleyball	Co-Rec Softball
Bowling	Fencing
Racquetball	Co-Rec Kickball
Team Table Tennis	Ultimate Frisbee
Darts	Track
3-Person Volleyball	Water Basketball
Foosball	Co-Rec Badminton
Team Call Pool	Team Badminton
Floor Hockey	3-on-3 Basketball
Spades	Foul Shooting
	3-Point Basketball
	Pickleball
	Euchre

Fitness and Wellness

The university is well aware that fitness is a vital contributor to an individual's well-being and productivity. For this reason the department is committed to providing the entire campus community with the opportunity and resources to keep fit for the new century.

The Fitness and Wellness program provides educational services, programs, workshops and seminars. Programs include cardio-respiratory fitness, muscular strength, blood pressure and stress reduction. Workshops include the topics of nutrition, weight control, stress management and lower back care and prevention. The Group X program provides over 30 exercise classes per week ranging from yoga and pilates to zumba and spinning.

Faculty

SUSAN BASSETT, Director of Athletics, Physical Education and Recreation – M.S., Indiana University; Carnegie Mellon, 2005—.

GARY ALDRICH, Associate Head Track & Field Coach/Instructor – M.S., Slippery Rock University; Carnegie Mellon, 2006—.

TERRY BODNAR, Assistant Football Coach/Instructor – M.S., Indiana University of PA; Carnegie Mellon, 1984—.

JOSH CENTOR, Assistant Director of Athletics – B.A., Brandeis University; Carnegie Mellon, 2008--.

DARIO DONATELLI, Head Men's Cross-Country & Track Coach/Instructor – B.S., Carnegie Mellon University; Carnegie Mellon, 1987—.

RICHARD ERDELYI, Assistant Football Coach and Head Golf Coach/Instructor – B.A., University of Pittsburgh; Carnegie Mellon, 1985—.

ANDREW GIRARD, Head Men's and Women's Tennis Coach/Instructor – B.S., Michigan Tech University; Carnegie Mellon, 2003—.

MIKE GRZYWINSKI, Assistant Intramural Director – B.S., Carnegie Mellon University; Carnegie Mellon, 1994—.

JUSTIN JENNINGS, Assistant Men's Basketball Coach/Instructor – MBA., Penn State Behrend; Carnegie Mellon, 2008—.

SEAN KAVANAUGH, Assistant Swimming Coach/Instructor – B.A., Ithaca College; Carnegie Mellon, 2005—.

KIM KELLY, Head Volleyball Coach/Instructor – MBA., Mt. St. Mary's University; Carnegie Mellon, 2005—.

MATTHEW KINNEY, Head Swimming and Diving Coach/Instructor – M.S., Western Illinois; Carnegie Mellon, 2007—.

RICHARD LACKNER, Head Football Coach /Instructor – B.A., Carnegie Mellon University; Carnegie Mellon, 1979—.

ARRON LUJAN, Head Men's Soccer Coach/Instructor – M.S., Virginia Commonwealth University; Carnegie Mellon, 2008—.

JASON MAKRINOS, Assistant Football Coach/Instructor – M.S., Slippery Rock University; Carnegie Mellon, 2008—.

MIKE MASTROIANNI, Director of Intramurals and Club Sports Coordinator/Assistant Athletic Director/Instructor – M.S., Slippery Rock University of Pa.; Carnegie Mellon, 1986—.

DONNA MOROSKY, Director of Fitness and Health/Instructor – Post-Graduate Education, University of Pittsburgh; Carnegie Mellon, 1975—.

SARA POMAYBO, Director of Aquatics/Assistant Swimming Coach/Instructor – M.S., Gannon University; Carnegie Mellon, 2005—.

MICHAEL PRANIAN, Assistant Men's Soccer Coach/Instructor – B.S., Virginia Polytechnic Institute & State University; Carnegie Mellon, 2008—.

CHRIS ROSE, Head Athletic Trainer/Instructor – M.S., Frostburg State University; Carnegie Mellon, 2005—.

GERRI SEIDL, Head Women's Basketball Coach/Instructor – B.S., University of Pittsburgh; Carnegie Mellon, 1984—.

PATTYE STRAGAR, Operations Manager for Fitness and Aquatics/Instructor – B.S., Northwestern University; Carnegie Mellon, 2003—.

BETSY WARREN, Assistant Women's Soccer Coach/Instructor – M.Ed., Ashland University; Carnegie Mellon, 2007—.

STEPHANIE WESTRICK, Assistant Athletic Trainer/Instructor – M.S., University of Wisconsin-Madison; Carnegie Mellon, 2008--.

SUE WILLARD, Head Women's Soccer Coach/Instructor – M.A., Washington College; Carnegie Mellon, 2005—.

TONY WINGEN, Head Men's Basketball Coach/Associate Athletic Director/Instructor – M.Ed., Springfield College; Carnegie Mellon, 1990—.

Reserve Officers' Training Corps (ROTC)

Department of Aerospace Studies (Air Force ROTC)

Mark T. McKenzie, Colonel, U.S. Air Force
Office: 2917 Cathedral of Learning, University of Pittsburgh

In the four-year commissioning program, a student takes the general military course (GMC) during the freshman and sophomore years, attends a four-week summer training program, and then takes the professional officer course (POC) in the junior and senior years. In the two-year commissioning program, a student attends a five-week summer training program following his or her junior year and then enters the POC. A student is under no contractual obligation to the Air Force until entering the POC or accepting an Air Force scholarship. In addition to the academic portion of the curriculum, each student attends two hours of leadership lab each week. This lab utilizes a student organization designed for the practice of leadership and management techniques. Two to three and a half year scholarships are available on a competitive basis to qualified students. Many AFROTC scholarships cover a portion of tuition costs, incidentals and lab fees, \$600 for books, plus pay each recipient \$250-\$400 per month.

General Military Course (GMC)

The subject matter for the freshman and sophomore years is developed from an historical perspective and focuses on the scope, structure, and history of military power with emphasis on the development of air power. The freshman courses explore the role of U.S. military forces, and the Air Force in particular, through a study of the total force structure, strategic offensive and defensive forces, general-purpose forces, and support forces. The sophomore courses include an introduction to the history of air power with emphasis on the development of concepts and doctrine governing the employment of U.S. air power.

Professional Officer Course (POC)

The Professional Officer Course, taken during the cadet's junior and senior years, concentrates on three main themes: the concepts and practices of management, leadership, and national defense policy. During the first term of the junior year, the course concentrates on a study of the management functions: planning, organizing, coordinating, directing and controlling. Basic and advanced management techniques, as found in the military and industrial environment, are explored. The second term deals with the application of general concepts of leadership to Air Force situations. As a basic study of human behavior, human relationships, and professional ethics, the course emphasizes the similarities between the problems encountered in the military and civilian environment. The first term of the senior course concentrates on selected elements of the U.S. government and national security process engaged in producing national strategy as well as various elements of U.S. military forces, doctrine, and employment capabilities. During the second term, the course concentrates on the strategic options available to the U.S. and on the manner in which policy choices are made. The course also includes a review of the military justice system.

For details about the two programs as well as information on the courses, scholarships and flying programs, interested students are encouraged to contact the Air Force ROTC detachment, or write to the Professor of Aerospace Studies, Air Force ROTC, 2917 Cathedral of Learning, University of Pittsburgh, Pittsburgh, PA 15260.

Department of Military Science (Army ROTC)

John N. Bender, Lieutenant Colonel, U.S. Army
Office: Bellefield Hall, Room 409, University of Pittsburgh

The Army Reserve Officers' Training Corps (ROTC) program supporting Carnegie Mellon University is located at the University of Pittsburgh. It exists to train the future officer leadership of the United States Army and offers opportunities and challenges that can put college students on the fast track to success in life. ROTC provides a combination of academics and important hands-on training, in addition to physical and mental challenges that will help students succeed in college and beyond. Through the training in ROTC, students will develop the confidence, self-esteem, motivation and leadership skills they will need regardless of their career plans.

The Four-Year Program

The traditional Four-Year program is divided into two parts. The Basic Course is taken in the freshman and sophomore years. There is no commitment for non-scholarship students at this level. Upon successful completion of the Basic Course, students are eligible for the Advanced Course, taken in the junior and senior years. At the beginning of the Advanced Course, students will decide whether or not they wish to become officers in the Army and enter into a formal contract. During the summer between the junior and senior years, students are required to attend the the Leader Development and Assessment Course (LDAC). Upon successful completion of a University degree and the Army ROTC program, students are commissioned into the United States Army as a Second Lieutenant.

The Two-Year Program

If the first two years of ROTC are not taken, students can attend the Leader's Training Course (LTC) during the summer between the sophomore and junior year. This camp will qualify students to begin the Advanced Course in their junior year or in the first year of a two-year graduate program. Or, if students have served in the active duty military, attended a military academy for one year, participated in JROTC for three years or belong to a Army National Guard or Army Reserve unit, they already qualify for entrance into the Advanced Course.

The Alternative Entry Program

The Alternative Entry Program is designed for academic junior students with no prior qualifying military training but are otherwise qualified. This option allows students to contract into the Advanced Course without receiving placement credit for the basic course. Students accepted into this program must complete the Leader's Training Course and the Leader Development and Assessment Course during the summer months.

Curriculum

Freshman Year

30-101	Introduction to Military Leadership	Fall
30-102	Foundations of Leadership	Spring

Sophomore Year

30-201	Leadership Dynamics & Application	Fall
30-202	Applications in Leadership & Combat Power	Spring

Junior Year

30-301	Basic Leader Planning & Combat Operations	Fall
30-302	Advanced Leadership Planning & Combat Operations	Spring

Leadership Development & Assessment Course
(six-week required summer camp)

Senior Year

30-401	Progressive Leadership Theory & Applications	Fall
30-402	Transition to the Profession of Arms	Spring

Army ROTC Scholarships

Army ROTC offers four, three and two year full scholarships with additional annual allowances of \$900 for books and a monthly stipend. High school, undergraduate and incoming two-year graduate students are eligible to apply. For application and information call ROTC at the University of Pittsburgh at (412) 624-6254/6197.

The Simultaneous Membership Program (SMP)

This program allows students to become members of the Army National Guard or the Army Reserves while enrolled in Army ROTC. Students in the Advanced Course who are SMP are paid for their Guard/Reserve training. The benefit of this program is that students in the Advanced Course are able to act as Army officers in their National Guard or Reserve unit, receiving valuable leadership experience.

Summer Programs

Leadership Development & Assessment Course

This 35-day camp is a requirement for all contracted students. Students attend the summer between their junior and senior year. Students are placed in various leadership positions throughout Camp and their skills and abilities will be tested and evaluated in preparation of a commission in the United States Army. All expenses are paid by the Army. Students are paid while attending.

Leader's Training Course

This 35-day camp is taken as a prerequisite for entry into the Advanced Course if the Basic Course cannot be fulfilled. It is taken the summer before the junior year. All expenses are paid by the Army. Students are paid while attending.

Army Adventure Training

ROTC students may participate in Airborne School, Air Assault School, Northern Warfare School and Mountain Warfare School the summer before the sophomore and junior year. These courses range from two to four weeks and students must arrive in top physical condition. All expenses are paid by the Army.

Extracurricular Activities

Rangers

Army ROTC students are eligible to participate in the Cadet Ranger Club. The Club conducts physically and mentally challenging extracurricular training to promote fitness, teamwork, self-confidence and fellowship. Training includes physical fitness, rappelling, rope bridging, tactics, hiking, climbing, weapons training and orienteering.

Scabbard & Blade

National Honor Society consisting of cadets/midshipmen from Army, Air Force and Naval ROTC.

Rho Tau Chi

Military fraternity established for the members of the various branches of ROTC. Purpose is to draw together cadets to increase communication and feelings of goodwill between the Cadet Corps and the community. Cadets participate in a variety of community service projects.

Color Guard

Dedicated group of Army ROTC cadets who train and perform to present the American flag and Army colors at football and basketball games and various community events.

Faculty

JOHN N. BENDER, Lieutenant Colonel, Professor of Military Science — M.S., Long Island University; Carnegie Mellon, 2004 —.

ANDREW R. KICK, Captain, Assistant Professor of Military Science — B.S., University of Dayton; Carnegie Mellon, 2005—.

ROY C. NICKERSON, Captain; Assistant Professor of Military Science — B.A., Western Kentucky University; Carnegie Mellon, 2004—.

Department of Naval Science (Naval ROTC)

Gregory Billy, Captain, U.S. Navy
Office: 4615 Forbes Avenue

The Department of Naval Science was established 16 December 1987. Its mission is to prepare young men and women mentally, morally, and physically, and to instill in them the highest qualities of duty, honor, and loyalty, in preparation for leadership positions in the naval service.

Carnegie Mellon's Naval Reserve Officers Training Corps (NROTC) is designed for young men and women who are seeking a challenging academic experience and who desire to serve their country as officers in the Navy or Marine Corps after graduation.

NROTC midshipmen lead the same campus life as other Carnegie Mellon students. They make their own arrangements for room and board, choose a preferred area of study and participate in extracurricular activities. Midshipmen wear civilian clothes to classes but wear uniforms one day of the week. NROTC students are active in all facets of university life; many are in positions of leadership in student government, on varsity and intramural sports teams, in campus clubs, and other student organizations. The NROTC program seeks students who are bright, ambitious, enthusiastic leaders whose lives are enriched by their education at Carnegie Mellon and by their involvement in NROTC.

Four-Year Scholarship Program

The four-year scholarship program provides full tuition and university fees, \$750 for textbooks per year, uniforms, and a \$250 per month tax-free subsistence allowance to students during their freshman year. This stipend then increases to \$300 during their sophomore year, \$350 for their junior year and \$400 for their senior year. Midshipmen must complete the university-approved curriculum of their choice, including courses in calculus and calculus-based physics (Navy Option Only), and specified courses in naval science subjects. Paid summer training periods are also provided. Scholarships are awarded on the basis of a nationwide competition before the start of the freshman year. Midshipmen commissioned through the scholarship programs become officers in the Navy or Marine Corps and incur a four-year active duty obligation in a selected area of the naval service.

Tweedale Scholarship Program

This scholarship program provides the same benefits as the four-year program, but is targeted toward currently enrolled students who have completed at least one, but not more than four semesters, and who are pursuing technical majors. This program allows a highly-qualified engineering, physics, chemistry, or mathematics student who has never applied for a NROTC scholarship in the past to be considered for this scholarship. Solid academic standing within his or her field of study is required, including a ranking within the top half of students pursuing his or her chosen course of study. If nominated by the Professor of Naval Science for this scholarship, the student will generally receive a scholarship decision within 5 working days from submission. Midshipmen commissioned through the scholarship programs become officers and incur a four-year active duty obligation in a selected area of the naval service.

College (Non-Scholarship) Programs in NROTC

Qualified students may participate in NROTC as college program (non-scholarship) midshipmen and earn commissions in the Navy or Marine Corps Reserve upon graduation. The active duty obligation for this program is three years. Students receive all naval science textbooks and uniforms. Additionally, if awarded advanced standing during their junior and senior years, they receive a tax-free subsistence monthly allowance of \$350 and \$400 respectively. A paid summer training period is provided between the junior and senior year. College program students may compete for three- and two-year scholarships described in the following paragraph.

College Program Three- and Two-Year Scholarships

Three-year scholarships are available on a competitive basis to those qualifying college program (non-scholarship) NROTC students who have demonstrated leadership and academic excellence during their freshman or sophomore year and are nominated for the scholarship by the Professor of Naval Science. Scholarship benefits are identical to those provided by the four-year scholarship

program. Active duty obligation is four years upon commissioning in a selected area of the naval service.

Two-Year National Scholarship Program

Sophomores who have not participated in the NROTC program may apply for a nationally competitive two-year NROTC scholarship. The two-year scholarship program provides the same benefits as the four-year program for a period of 20 months. Students must apply for this program no later than February of their sophomore year. Students selected for this program attend the Naval Science Institute during the summer before their junior year to complete required naval science course material. A paid summer training period is provided between the junior and senior years. Commissionees incur a four-year active duty obligation upon graduation in a selected area of the naval service.

Curriculum

The sequence of naval science courses is the same for all officer candidates for the first three semesters. Midshipmen accepted into the Marine Corps option program will have curriculum variations starting with their third year. Additionally, some candidates may be required to complete courses in American military affairs, national security policy, English, mathematics, and/or the physical sciences. Descriptions of the course requirements for each candidate classification (scholarship/college program) may be obtained from the Department of Naval Science office.

All scholarship and college program students are required to attend a weekly 1.5 hour Naval Laboratory (32-100) where professional orientation, military drill, physical fitness, and leadership are emphasized. Guest speakers from the Fleet are frequent participants in these laboratories.

Naval Science courses are open to all students. Since these are required courses for NROTC students, they will be given priority in enrollment. Remaining spaces will be filled through the normal university registration process.

Naval Professional Academic Courses (Naval Science Courses)

Freshman Year

32-100	Naval Laboratory	3
32-101	Introduction to Naval Science	6
32-102	Sea Power and Maritime Affairs	6

Sophomore Year

32-200	Naval Laboratory	3
32-201	Leadership and Management	6
32-212*	Navigation	9

Junior Year

32-300	Naval Laboratory	3
32-310**	Evolution of Warfare	9
32-311*	Engineering	9
32-312*	Weapons Systems	9

Senior Year

32-400	Naval Laboratory	3
32-402	Leadership and Ethics	6
32-410**	Amphibious Warfare	9
32-411*	Naval Operations and Seamanship	9

* Required of students in the Navy Option

** Required of students in the Marine Option

All other courses are required of all students in the program.

Faculty

GREGORY BILLY, Professor of Naval Science — Captain, U.S. Navy; B.S. Mechanical Engineering, United States Naval Academy; Carnegie Mellon, 2008—present.

JOSEPH GRANT, Associate Professor of Naval Science — Lieutenant Colonel, U.S. Marine Corps; B.S. Systems Engineering, Ohio State University; M.A. Management, Naval Postgraduate School; Carnegie Mellon, 2008—present.

ALEX LEARY, Assistant Professor of Naval Science — Lieutenant, U.S. Navy; B.S. Mechanical Engineering, University of Virginia; M.S. Bioengineering, University of Pittsburgh; Carnegie Mellon, 2008—present.

BRIAN PATTERSON, Assistant Professor of Naval Science — Lieutenant, U.S. Navy; B.S. Marine Systems Engineering, United States Merchant Marine Academy; Carnegie Mellon, 2007—present.

JOSEPH THOMPSON, Assistant Professor of Naval Science — Lieutenant, U.S. Navy; B.S. Ocean Engineering, United States Naval Academy; Carnegie Mellon, 2006—present.

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Intercollege Programs

Bachelor of Humanities and Arts Degree Program

Sponsored by the College of Humanities and Social Sciences and the College of Fine Arts
Office: Margaret Morrison Carnegie Hall, Room 107
www.cmu.edu/interdisciplinary

Carnegie Mellon University offers an interdisciplinary degree that combines the strengths of the College of Fine Arts (CFA) and the College of Humanities and Social Sciences (H&SS). The intercollege degree, called the Bachelor of Humanities and Arts (BHA), offers depth of study in both the fine arts and the humanities, social and behavioral sciences. The BHA Degree Program enables a student to receive broader exposure to the humanities and liberal arts than is generally possible through a Bachelor of Fine Arts degree in CFA, while obtaining deeper and more substantial training in the fine arts than is generally possible through a Bachelor of Arts or Bachelor of Science degree in H&SS. Students receive extensive training in one or more of the fine arts disciplines as well as related advanced training in areas such as writing, social sciences, behavioral sciences, or cultural studies. The program also provides enough flexibility to allow students to explore other areas of interest. The most important aspect of the BHA Program is for students to blend their interests, and to explore the connections between their chosen disciplines.

The BHA curriculum is divided into three parts: 1) General Education coursework, 2) CFA concentration coursework, and 3) H&SS concentration coursework.

Students choose their fine arts concentration from among the five schools in CFA: Architecture, Art, Design, Drama, or Music. A student must meet the entry requirements for the particular CFA school of their choice. While in the BHA Program, a student may change their CFA concentration only if they pass all admission requirements for that particular school.

Students choose their humanities or social/behavioral sciences concentration from the list of majors and minors offered by H&SS, or by self-designing an interdepartmental concentration.

The BHA Degree Program is governed by faculty and administrators from both colleges and led by the director of the BHA, BSA, and BCSA Programs. The director and associate director of the BHA, BSA, and BCSA Programs are the primary advisors and liaisons between CFA and H&SS. Students receive extensive advising support. Each student has two additional academic advisors: an advisor in the admitting school of CFA for their fine arts concentration, and an advisor in H&SS for their humanities/social sciences concentration. This network of advisors guides each student through their curriculum.

Senior Project Course Option

The BHA Program offers a senior project option. The creation and completion of such a project can be an important, integrative and fulfilling capstone. It can also provide an academic goal for BHA "sub-seniors," as well as influence the development of the BHA Program as a distinguished scholarly and creative undergraduate student community.

Masters of Arts Management (MAM) Option

BHA students who have an interest in arts management and wish to go on for an advanced degree may select courses in their sophomore and junior years to prepare them for this area. A student in the junior year may apply to the Accelerated Master's Program with the H. John Heinz III School of Public Policy and Management. In this program students take both graduate and undergraduate courses in the senior year, earn the BHA degree, and continue on for an additional year to complete the work for the Masters of Arts Management (MAM) degree.

BHA Curriculum

I. BHA General Education	84 units
II. H&SS Concentration	54 units
III. CFA Concentration	108 units
IV. Free Electives	114 units
BHA Degree Requirements	360 units

I. BHA General Education (GenEd)

(10 courses, 84 units minimum)

BHA students are required to fulfill the following General Education requirements, an interdisciplinary seminar requirement, and a university computing course.

- Communicating: Language and Interpretations (3 courses, 27 units minimum, 76-101 required, two approved modern language courses required)
- Reflecting: Societies and Cultures (1 course, 9 units minimum, 79-104 required)
- Modeling: Mathematics and Experiments (1 course, 9 units minimum)
- Deciding: Social Sciences and Values (3 courses, 27 units minimum, 36-201 required)
- BHA, BSA, & BCSA Freshman Research Seminar (1 course, 9 units, 62-190 required)
- University Requirement: Computing @ Carnegie Mellon (1 mini-course, 3 units, to be completed in first semester)

Communicating: Language and Interpretations (3 courses, complete 27 units minimum)

Courses in this category give special attention to the study of language as interpretation, expression and argument within and across multiple discourses. Students examine language for its internal logics and structures.

76-101 Interpretation and Argument – REQUIRED
If a score of 5 is obtained on the either English Advanced Placement examination, approved English substitutions at the 200 and 300 level are available.

Modern Languages - REQUIRED to complete two courses taught in a language offered by the Modern Language Department. A wide selection of courses are offered in Chinese, French, German, Italian, Japanese, Russian, and Spanish. Students must complete two courses in the same language. Languages taught at other institutions are also acceptable (with advisor approval).

Reflecting: Societies and Cultures (1 course, complete 9 units minimum)

This category emphasizes the study of history, society, and culture from local and global perspectives.

79-104 Introduction to World History - REQUIRED

Modeling: Mathematics and Experiments (1 course, complete 9 units minimum)

Courses in this category stress the interplay of mathematical (formal) theories and experimental work. Some courses investigate the internal structure of theories, whereas others use them as models for producing real-world knowledge. Such models may be drawn from a variety of disciplines including the natural sciences, but also, for example, psychology and computer science. The interactions between theorizing and experimenting (observing) can be understood within an intellectual framework that invites comparative assessment. Select from the following course options:

Mathematics

21-110	Problem Solving in Recreational Mathematics
21-111	Calculus I
21-112	Calculus II*
21-120	Differential and Integral Calculus
21-121	Integration and Differential Equations*
21-122	Integration, Differential Equations and Approximation*
21-123	Calculus of Approximations (5 units)*
21-127	Concepts of Mathematics
21-131	Analysis I*
21-132	Analysis II*
21-141	Matrix Algebra*
21-256	Multivariate Analysis and Approximation*
21-259	Calculus of Three Dimensions*
80-110	Nature of Mathematical Reasoning
80-210	Logic and Proofs
80-211	Logic and Mathematical Inquiry

Natural Science

03-121	Modern Biology
03-122	Organismic Botany*
03-125	Evolution and the History of Life*
03-130	Introduction to Mammalian Physiology*
03-130	Biology of Organisms*
03-203	Bench to Bedside: Process of Regenerative Therapeutics (6 units)
03-204	Information, Entropy, and Noise in the Brain (6 units)*
03-231/232	Biochemistry I & II*
03-310	Introduction to Computational Biology*
03-360	The Biology of the Brain (Intro. to Neuroscience)*
09-101	Introduction to Experimental Chemistry (3 units)
09-103	Atoms, Molecules and Chemical Change (non-major)
09-104	Fundamental Aspects of Organic Chemistry/Biochemistry (non-major)
09-105	Introduction of Modern Chemistry I
09-106	Modern Chemistry II*
09-217	Organic Chemistry I*
09-218	Organic Chemistry II*
09-221	Laboratory I: Introduction to Chemical Analysis*
09-222	Laboratory II: Organic Synthesis and Analysis
33-106	Physics I for Engineering Students*
33-107	Physics II for Engineering Students*
33-111/112	Physics I & II for Science Students*
33-114	Physics of Musical Sound
33-115	Energy and Environmental Issues
33-124	Introduction to Astronomy
33-131	Matter and Interactions I*
33-132	Matter and Interactions II*
33-211	Physics III: Modern Essentials*
33-213	Mini-Courses in Special Relativity* (4 units)
33-224	Stars, Galaxies, and the Universe*
33-355	Nanoscience and Nanotechnology*
99-230	Environmental Geology

Other Courses

05-291	Human-Computer Interaction for Non-Majors
05-413	Human Factors
06-100	Introduction to Chemical Engineering
12-090	Technology and the Environment
12-100	Intro. to Civil and Environmental Engineering*
15-100	Introductory/Intermediate Programming
15-105	Principles of Computation
15-111	Intermediate/Advanced Programming
15-123	Effective Programming in C and UNIX
18-100	Introduction to Electrical & Computer Engineering*
19-101	Introduction Engineering & Public Policy*
24-101	Introduction to Mechanical Engineering*
27-100	Engineering Materials of the Future*
36-202	Statistical Methods*
36-310	Fundamentals of Statistical Modeling*
36-350	Data Mining*
42-101	Introduction to Biomedical Engineering
79-333	History of Biomedical Research
80-220	Philosophy of Science
80-222	Measurement and Methodology
80-226	Revolution in Science
80-312	Philosophy of Mathematics
80-322	Philosophy of Physics
80-323	Philosophy of Biology
85-355	Intro. to Cognitive Neuroscience*
85-370	Perception*
85-392	Human Expertise*
85-406	Autism: Psychological and Neuroscience Perspectives*
85-412	Cognitive Modeling*

85-414	Cognitive Neuropsychology*
85-419	Introduction to Parallel Distributed Processing*
85-423	Cognitive Development*
85-429	Cognitive Brain Imaging*
88-110	Experiments with Economic Principles
88-360	Behavioral Economics*
88-391	Technology and Economic Growth
99-238	Materials, Energy and Environment

Deciding: Social Sciences and Values
(3 courses, complete 27 units minimum)

The theme of this category is the exploration of cognitive, behavioral and ethical dimensions of decision-making on both the individual and social level. Making decisions requires a broad understanding of human rationality and social interaction. Some courses examine the critical collection and analysis of data for achieving such an understanding, whereas others emphasize the historical development of policies and values, which form the matrix for decision-making.

36-201	Statistical Reasoning - REQUIRED
36-220	Engineering Statistics and Quality Control
36-247	Statistics for Lab Sciences
36-303	Sampling Surveys and Society*
73-100	Principles of Economics
73-150	Microeconomics*
79-222	Religion in American Society
79-342	Intro. to Science and Technology Studies
79-348	Objects of Value
80-130	Introduction to Ethics
80-136	Social Structure, Public Policy & Ethical Dilemmas
80-208	Critical Thinking
80-221	Philosophy of Social Science
80-230	Ethical Theory
80-235	Political Philosophy
80-237	Politics, Philosophy and Economics
80-241	Ethical Judgments in Professional Life
80-242	Conflict and Dispute Resolution
80-243	Business Ethics
80-244	Environmental Ethics
80-245	Medical Ethics
80-270	Philosophy of Mind
80-271	Philosophy and Psychology
80-305	Rational Choice (cross-listed as 88-356)
80-321	Causation and Social Policy*
80-335	Seminar: Philosophy, Politics, and Economics
80-336	Philosophy and Law
80-338	Health, Development, and Human Rights
80-341	Computers and Ethics
80-430	Ethics and Medical Research
85-102	Introduction to Psychology
85-211	Cognitive Psychology
85-213	Human Information Processing and Artificial Intelligence
85-219	Biological Foundations of Behavior
85-221	Principles of Child Development
85-241	Social Psychology
85-251	Personality
85-261	Abnormal Psychology
85-395	Applications of Cognitive Science*
88-104	Decision Processes in American Political Institutions
88-120	Reason, Passion, and Cognition
88-307	Principles of Individual and Collective Irrationality
88-358	Policy Making Institutions*

* Indicates co-requisites and/or prerequisites required.

Freshman Research Seminar (1 course, 9 units)

This course introduces freshmen and sophomore students in the Bachelor of Humanities and Arts (BHA), Bachelor of Science and Arts (BSA), and Bachelor of Computer Science and Arts (BCSA) Programs to research methodology. It examines the two main paradigms that form the basis of research in various fields of inquiry: 1) the systematic, scientific, or positivist approach, and 2) the qualitative, ethnographic, and ecological or naturalistic approach. This course is taught by the director with the participation of guest lecturers when appropriate.

62-190 BHA, BSA, & BCSA Freshman Seminar - REQUIRED

University Requirement (1 mini-course, 3 units)

This is a mini-course, pass/no credit, to be completed in the 1st semester.

99-10x Computing @ Carnegie Mellon (99-101, 99-102, 99-103)

II. College of Humanities and Social Sciences Concentration

(6 courses, 54 units minimum)

Each student meets individually with a BHA H&SS Academic Advisor to design a 54-unit H&SS concentration based on existing H&SS majors /minors, or by creating a self-defined interdepartmental concentration. Please refer to the H&SS section of this catalog to review the individual majors and minors offered.

III. College of Fine Arts Concentration

(number of courses vary, 108 units minimum)

BHA students choose one of the following concentrations:

- Architecture
- Art
- Design
- Drama
- Music

ARCHITECTURE CONCENTRATION (108 units minimum)

Required Courses (54 units minimum)

48-100	Design Fundamentals	12 units
or		
48-095	Architecture for Non-Majors	9 units
48-130	Architectural Drawing I: Tactile Foundation	9 units
48-135	Architectural Drawing II: Appearance	9 units
48-240	Survey of World Architecture & Urbanism	9 units
48-34x	Architectural History Lecture (varying topics)	9 units
48-44x	Architectural History Lecture (varying topics)	9 units

Complete one of the following Elective Foci, or design your own focus in consultation with the Architecture advisor (54 units minimum):

Elective Focus: General Education in Architecture (54 units)

48-120	Computer Modeling I	9 units
48-210	Statics (prerequisite: 33-106)	9 units
48-215	Materials and Assembly (prerequisite: 48-210)	9 units
48-217	Structures I (prerequisite: 48-210)	9 units
48-230	Drawing III: Perspective (prerequisite: 48-135)	9 units
48-315	Environment I: Climate and Energy (prerequisite: 33-106)	9 units
48-351	Human Factors in Architecture	9 units
48-34x	Architectural History Lecture (varying topics)	9 units
48-44x	Architectural History Lecture (varying topics)	9 units
48-452	Real Estate Design and Development	9 units
48-453	Urban Design	9 units
48-551	Ethics and Decision Making in Architecture	9 units
48-5xx	Departmental Elective (prerequisites vary)	9 units

Elective Focus: Architectural Representation and Visualization (54 units)

This sequence is intended to develop particular skills in architectural representation.

48-120	Introduction to Digital Media I	9 units
48-125	Introduction to Digital Media II	9 units
48-230	Architectural Drawing III: Perspective (prerequisite: 48-135)	9 units
48-563	Building Virtual Worlds	9 units
48-7xx	Graduate Elective	9 units
48-7xx	Graduate Elective	9 units

Elective Focus: Architectural Technology (Six varying topics, 54 units)

This sequence is intended to develop intellectual links to the technical aspects of the profession.

Prerequisite Courses:

21-120	Differential and Integral Calculus	10 units
33-106	Physics I for Engineering Students	12 units
or		
48-115	Physics for Architecture	9 units

Elective Courses:

48-210	Statics (prerequisite: 33-106 or 48-115)	9 units
48-215	Materials and Assembly (prerequisite: 48-210)	9 units
48-217	Structures (prerequisite: 48-210)	9 units

48-315	Environment I: Climate and Energy (prerequisite: 33-106 or 48-115)	9 units
48-410	Environment II: Space, Sound, and Light (prerequisite: 33-106 or 48-115)	9 units
48-412	Environment III: Mechanical Systems	9 units
48-415	Advanced Building Systems (prerequisite: 48-315)	9 units
48-4xx	Designated Departmental Technical Elective	9 units

Elective Focus: Architectural History (six varying topics, 54 units)

48-34x/44x	Architectural History	9 units
48-34x/44x	Architectural History	9 units
48-34x/44x	Architectural History	9 units
48-34x/44x	Architectural History	9 units
48-34x/44x	Architectural History	9 units
48-34x/44x	Architectural History	9 units

ART CONCENTRATION (108 units minimum)

PORTFOLIO REVIEW REQUIRED FOR ADMISSION

Concept Studios (2 courses, 20 units)

Complete two courses:

60-101	Concept Studio I	10 units
60-102	Concept Studio II	10 units
60-201	Concept Studio III	10 units
60-202	Concept Studio: EcoArt	10 units

Media Studios (3 courses, 30 units)

Complete three courses:

60-150	2-Dimensional Studio I	10 units
60-151	2-Dimensional Studio II	10 units
60-250	2-Dimensional Studio III	10 units
60-251	2-Dimensional Studio IV	10 units
60-130	3-Dimensional Studio I	10 units
60-230	3-Dimensional Studio II	10 units
60-110	Electronic Media Studio I	10 units
60-210	Electronic Media Studio II	10 units

Advanced Studios (4 courses, 40 units)

Complete four courses. Courses may be offered in the fall and/or spring. Students may take courses in any media area (ETB, PDP or SIS). They may take all courses in one media area if a focus is desired.

60-410-29	Advanced Electronic and Time-Based Work (ETB)	10 units
60-430-49	Advanced Sculpture, Installation and Site-Work (SIS)	10 units
60-450-98	Advanced Painting, Drawing and Printmaking (PDP)	10 units
60-499	Studio- Independent Study (one only)	10 units

Art History/Theory (2 courses, 18 units)

60-205	Modern Visual Culture: 1789-1945	9 units
60-206	Contemporary Visual Culture: 1945 to the Present	9 units

NOTE: To complete the full three-semester historical sequence, take 60-105, Pre-Industrial Visual Cultures, 9 units.

Review Requirement (Complete 2 required reviews, 0 units)

A review is required at the end of the sophomore and senior years. Pass/fail only.

60-200	Sophomore Review (Spring)
60-400	Senior Review (Spring)

DESIGN CONCENTRATION (108 units minimum)

PORTFOLIO REVIEW REQUIRED FOR ADMISSION

Design Required Courses (81 units)

51-101	Design Studio I (Fall)	9 units
51-102	Design Studio II (Spring)	9 units
51-121	Design Drawing I (Fall)	9 units
51-122	Design Drawing II (Spring)	9 units
51-132	Introduction to Photo Design (Spring)	9 units
51-171	Human Experience in Design (Fall)	9 units
51-174	History of Objects and Images (Spring)	9 units

51-271	Design History I (Fall)	9 units
51-272	Design History II (Spring)	9 units
64-100	Critical Histories of the Arts	9 units

Design Electives (27 units)

Choose three (3) additional Design courses in consultation with the Design advisor.

NOTE: BHA Design students have 114 units of electives built into their program, any portion of which can be taken in Design. These additional courses must also be chosen in consultation with the Design advisor and respect all prerequisite requirements, etc.

DRAMA CONCENTRATION (108 units minimum)

AUDITION/INTERVIEW REQUIRED FOR DIRECTING OR DRAMATURGY OPTIONS, PORTFOLIO REVIEW/INTERVIEW REQUIRED FOR DESIGN OR PRODUCTION TECHNOLOGY AND MANAGEMENT OPTIONS.

Options available in the following areas: 1) Production Technology and Management, 2) Dramaturgy, 3) Directing, 4) Design

There is no BHA/BSA/BCSA acting or musical theatre option.

The BHA/BSA/BCSA Drama candidate must choose from the four options offered by The School of Drama and successfully pass the audition/interview for Directing or Dramaturgy Options, or the portfolio review/interview for the Design or Production Technology and Management Options. All BHA/BSA/BCSA students are required to take courses 54-177 and 54-179 Foundations of Drama I and II, 54-151 and 54-152 Stagecraft, and 54-175 and 54-176 Conservatory Hour in the freshman year, 54-259 or 54-262 Production Preparation II in one of the semesters of the sophomore year (4-8 weeks per term), and 54-281 and 54-282 Foundations of Drama III and IV during junior or senior year.

Drama Required Courses: (46 units)

54-177, 54-179 Foundations of Drama I and II (freshman year, 6 units per semester) 12 units

54-281, 54-282 Foundations of Drama III and IV (taken anytime from sophomore to senior year, in sequence, 6 units per semester) 12 units

(Note: All Foundations courses are one-semester courses)

54-151, 54-152 Stagecraft

(Includes work on production run-crews and a large classroom component. This is a time-intensive course. BHA/BSA students can modify this commitment in terms of hours and units in consultation with the Drama advisor. Minimum 5 units for classroom work, 6 units for production work. Taking the full 15 units in the fall and 11 units in the spring is recommended but not required.) 11 units minimum

54-259 or 54-262 Production Preparation II (sophomore year, fall or spring semester) 9 units

54-175, 54-176 Conservatory Hour (freshman year, 1 unit per semester, two semesters) 2 units

Drama Electives: (62 units)

Choose additional courses from the Drama catalogue in consultation with the Drama advisor, given the appropriate prerequisites are in place and with permission of instructors where necessary.

Note: BHA Drama students have 114 units of electives built into their program, any portion of which can be taken in Drama. These additional courses must also be chosen in consultation with the Drama advisor and respect all prerequisite and instructor permission requirements.

MUSIC CONCENTRATION (108 units minimum)

AUDITION AND INTERVIEW REQUIRED FOR MUSIC CONCENTRATION OPTION. INTERVIEW REQUIRED FOR MUSIC HISTORY AND CULTURE OR MUSIC TECHNOLOGY CONCENTRATION OPTION.

Options available in the following areas: 1) Music (instrumental, piano, organ, composition, voice) , 2) Music History and Culture, 3) Music Technology.

Required Courses for All Concentration Options

57-152	Harmony I	6 units
57-173	Survey of Western Music History	9 units
57-189	Repertoire and Listening for Musicians I	3 units

Music

Required:		
57-xxx	BHA/BSA Studio (4 semesters)	36 units
57-xxx	Major Ensemble (4 semesters)	24 units
57-161	Eurhythmics I	3 units
57-181	Solfege I	3 units

Choose 24 units from:

57-153	Harmony II	6 units
57-283	Music History I	9 units
57-284	Music History II	9 units
57-289	Repertoire and Listening for Musicians III*	3 units
57-290	Repertoire and Listening for Musicians IV*	3 units
57-162	Eurhythmics II	3 units
57-163	Eurhythmics III	3 units
57-164	Eurhythmics IV	3 units
57-182	Solfege II	3 units
57-183	Solfege III	3 units
57-184	Solfege IV	3 units

Music History and Culture

Required:		
57-283	Music History I	9 units
57-284	Music History II	9 units
57-289	Repertoire and Listening for Musicians III*	3 units
57-290	Repertoire and Listening for Musicians IV*	3 units
57-611	Independent Study in Music History	6 units

Choose 36 units from:

57-209	Beatles	9 units
57-457	Jazz History I	6 units
57-458	Jazz History II	6 units
57-202	Opera History	9 units
57-477	Music and the Spirit	6 units
57-480	History of Black American Music	6 units

Choose 24 additional Music units in consultation with the Music advisor.

Music Technology

Required:		
57-181	Solfege I	3 units
57-101	Introduction to Music Technology	6 units
57-347	Electronic and Computer Music	6 units
57-337	Sound Recording	6 units
57-xxx	Independent Study in Music Technology or Sound Recording	9 units

Choose 36 units from:

57-153	Harmony II	6 units
57-338	Sound Editing and Mastering	6 units
57-438	Multitrack Recording	9 units
57-283	Music History I	9 units
57-284	Music History II	9 units
57-289	Repertoire and Listening for Musicians III*	3 units
57-290	Repertoire and Listening for Musicians IV*	3 units
57-182	Solfege II	3 units

Choose 24 additional Music units in consultation with the Music advisor.

*co-requisite for Music History I and II

INTERDISCIPLINARY CONCENTRATION (108 units minimum)

BHA students may combine a minimum of 108 units from two or more areas in the fine arts, with a complementary 54 units from two or more areas in the humanities and/or social sciences. Interdisciplinary areas to consider: arts and society, visual and verbal communication, the arts and organizations, performance and theory, comparative arts.

IV. Free Electives

(approximately 13 courses, 114 units)

Take any Carnegie Mellon course. Many BHA students use their electives to broaden or deepen their concentrations. A maximum of 9 units of physical education and/or military science may be counted toward this requirement. Physical education and military science courses will not be calculated in a student's QPA.

Bachelor of Science and Arts Degree Program

Sponsored by the Mellon College of Science and the College of Fine Arts
Office: Margaret Morrison Carnegie Hall, Room 107
www.cmu.edu/interdisciplinary

Carnegie Mellon University recognizes that there are students who are naturally gifted in both the fine arts and the natural sciences or mathematics. In order to accommodate students who want to pursue an education simultaneously in these areas, we offer a degree that combines the strengths of the College of Fine Arts (CFA) and the Mellon College of Science (MCS). The intercollege degree, called the Bachelor of Science and Arts (BSA), is a rigorous program that offers a unique group of qualified students the opportunity to develop their talents and interests in an area of the fine arts and an area of the natural sciences or mathematics.

The BSA curriculum is divided into three parts: 1) BSA Core requirements, 2) CFA concentration coursework, and 3) MCS concentration coursework.

Students choose their fine arts concentration from among the five schools in CFA: Architecture, Art, Design, Drama or Music. A student must meet the entry requirements for the particular CFA school of their choice. While in the BSA Program, a student may change their CFA concentration only if they pass all admission requirements for that particular school.

Students choose their science concentration from among the four departments in MCS: Biological Sciences, Chemistry, Mathematical Sciences, or Physics.

The BSA Degree Program is governed by faculty and administrators from both colleges and led by the director of the BHA, BSA, & BCSA Programs. The director and associate director of the BHA, BSA, and BCSA Programs are the primary advisors and liaisons between CFA and MCS. Students receive extensive advising support. Each student has two additional academic advisors: an advisor in the admitting school of CFA for their fine arts concentration, and an advisor in MCS for their natural sciences/mathematics concentration. This network of advisors guides each student through their curriculum.

Senior Research/Project Course Option

The BSA program offers a senior project option. The creation and completion of such a project can be an important integrative and fulfilling capstone. It can also provide an academic goal for BSA "sub-seniors," as well as influence the development of the BSA program as a distinguished scholarly and creative undergraduate student community.

BSA Curriculum

I. BSA Core	108 units
II. MCS Concentration	120-134 units
III. CFA Concentration	108 units
IV. BSA Free Electives	30-44 units
BSA Degree Requirements	380 units

I. BSA Core (12 courses, 108 units minimum)

- Writing/Expression (1 course, 9 units, 76-101 required)
- BHA, BSA, & BCSA Freshman Research Seminar (1 course, 9 units, 62-190 required)
- Cultural Analysis (1 course, 9 units minimum)
- Economic, Political, & Social Institutions *OR* Cognition, Choice & Behavior (1 course, 9 units minimum)
- Two additional courses from one of the following departments: English, History, Modern Languages, Philosophy, or Psychology (2 courses, 18 units)
- Mathematics (2 courses, 20 units, 21-120 and 21-122 required)
- Science (3 courses, 31 units, 03-121, 09-105, and 33-xxx required)
- University Requirement: Computing @ Carnegie Mellon (1 mini-course, 3 units, to be completed in first semester)

Writing/Expression (1 course, 9 units)

Broadly considered, language is a tool used to communicate, as well as a way to organize non-visual and non-mathematical thinking. This requirement focuses on the social nature of language and the ways in which writing constitutes thinking.

76-101 Interpretation and Argument - REQUIRED

If a score of 5 is obtained on the either English Advanced Placement examination, approved English substitutions at the 200 and 300 level are available.

Freshman Research Seminar (1 course, 9 units)

This course introduces freshmen and sophomore students in the Bachelor of Humanities and Arts (BHA), Bachelor of Science and Arts (BSA), and Bachelor of Computer Science and Arts (BCSA) Programs to research methodology. It examines the two main paradigms that form the basis of research in various fields of inquiry: 1) the systematic, scientific, or positivist approach, and 2) the qualitative, ethnographic, and ecological or naturalistic approach. This course is taught by the director with the participation of guest lecturers when appropriate.

62-190 BHA, BSA, & BCSA Freshman Seminar - REQUIRED

Cultural Analysis (1 course, complete 9 units minimum)

This category explores definitions of culture and the role culture plays in producing different actions and institutions as well as the roles of institutions, systems and human actions in shaping cultural contexts. Listed below are examples of courses that meet the requirement for this category.

76-201	Cultural Practices and Literary Production
76-227	Comedy
79-104	Introduction to World History
79-110	The Development of European Culture
79-111	Cultural and Cross-Cultural Perspectives on the Environment
79-112	Race, Nationality, and the Development of American Cultures
79-113	Culture and Identity in American Social Life
79-116	Debates and Controversies: Cultural Differences in Action
79-201	Introduction to Anthropology
79-206	Development of American Culture
79-368	Poverty, Charity and Welfare
80-100	What Philosophy Is
80-182	Language, Culture and Thought
80-250	Ancient Philosophy
80-251	Modern Philosophy
80-253	Continental Philosophy
80-254	Analytical Philosophy
80-255	American Pragmatism
82-2xx	Any 200 level or greater course from Modern Languages

Economic, Political & Social Institutions *OR* Cognition, Choice & Behavior

(1 course from either category, complete 9 units minimum)

Economic, Political & Social Institutions

This category examines the ways in which institutions organize individual preferences and actions into collective outcomes using model-based reasoning.

36-303	Sampling, Surveys, and Society
73-100	Principles of Economics
73-110	Experiments with Economic Principles
79-115	Education and Inequality
79-266	Times of Feast/Famine: Population and Family in History
80-135	Classical Political Philosophy
80-136	Ethics and Public Policy
88-104	Decision Processes in American Political Institutions
88-105	Introduction to World Politics
88-109	Institutions and Individuals

Cognition, Choice, and Behavior

This category use model-based analysis to broaden an understanding of human thinking, choices, and behavior on an individual basis across a variety of settings.

80-150	Nature of Reason
80-180	The Nature of Language
80-181	Language and Thought
80-242	Conflict and Dispute Resolution
80-270	Philosophy of Mind
85-100	Cognitive Processes: Theory and Practice

85-102	Introduction to Psychology
85-150	Introduction to Social Problems
85-211	Cognitive Psychology
85-221	Developmental Psychology
85-241	Social Psychology
85-251	Introduction to Personality
88-120	Reason, Passion, and Social Cognition

Complete TWO additional courses from one of the following departments: English, History, Modern Languages, Philosophy, or Psychology

(2 courses, complete 18 units minimum)

Mathematics (2 courses, 20 units)

Complete these two courses in Calculus:

21-120	Differential & Integral Calculus
21-122	Integration, Differential Equations, and Approximation

Science (3 courses, 31 units)

Complete the following science courses:

03-121	Modern Biology
09-105	Introduction to Modern Chemistry
33-xxx	Physics for Science Students I

University Requirement (1 mini-course, 3 units)

This is a mini-course, pass/no credit, to be completed in the 1st semester.

99-10x	Computing @ Carnegie Mellon (99-101, 99-102, 99-103)
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II. MCS Concentration

(number of courses vary, 120-134 units)

BSA students choose one of the following concentrations:

• Biological Sciences	120 units
• Chemistry	122 units
• Mathematical Sciences	121 units
• Physics	134 units

BIOLOGICAL SCIENCES CONCENTRATION

(120-123 units minimum)

Biology Required Courses (102 units)

03-231 or		
03-232	Biochemistry	9 units
03-240	Cell Biology	9 units
03-330	Genetics	9 units
03-124 or		
03-343	Biology Laboratory	9-12 units
03-201 and/or		
03-202	Undergraduate Colloquium	2 units
09-106	Modern Chemistry II	10 units
09-217	Organic Chemistry I	9 units
09-218	Organic Chemistry II	9 units
09-221	Laboratory I: Introduction to Chemical Analysis	12 units
09-222	Laboratory II: Organic Synthesis and Analysis	12 units
33-112	Physics for Science Students II	12 units

Biology Electives (2 courses, 18 units)

Must be selected from 03-3xx, excluding 03-445

CHEMISTRY CONCENTRATION (122 units minimum)

Required Courses (104 units)

09-106	Modern Chemistry II	10 units
09-214/344/345	Physical Chemistry	9 units
09-348	Inorganic Chemistry	10 units
09-221	Chem Lab I	12 units
09-222	Chem Lab II	12 units
09-321	Chem Lab III	12 units
09-204	Issues in Chemistry	3 units
09-201, 202, & 301	Undergraduate Seminars (1 unit each)	3 units
09-402	Undergraduate Seminar	3 units
33-112	Physics for Science Students II	12 units

Advanced Chemistry Electives (2 courses, 18 units)

May be any upper level chemistry course, 09-3xx or higher, or Biochemistry, 03-231 or 03-232, with the exception of 09-435, Independent Study, which can be used only by permission of the Director of Undergraduate Studies.

MATHEMATICAL SCIENCES CONCENTRATION (121 units minimum)

Required Courses (85 units)

(Reasonable substitutions within the core program will be allowed.)

21-127	Concepts of Mathematics	9 units
21-228	Discrete Mathematics	9 units
21-241	Matrix Algebra I (or 21-341 Linear Algebra)	9 units
21-259	Calculus in Three Dimensions	9 units
21-260	Differential Equations	9 units
21-355	Principles of Real Analysis I	9 units
21-373	Algebraic Structures	9 units
33-112	Physics for Science Students II	12 units
15-100	Introductory/Intermediate Programming	10 units

Math Sciences Electives (2 courses, 18 units)

Students with a music focus should take 21-372 (Partial Differential Equations).

Math Sciences, Statistics, or Computer Science Electives (2 courses, 18 units)

May be computer science course above the 100 level, mathematical science courses beyond the calculus sequence, and statistics course at the level of 36-225 or higher.

PHYSICS CONCENTRATION (132-135 units minimum)

Required Courses (114 units)

33-112	Physics for Science Students II	12 units
33-104	Experimental Physics	9 units
33-211	Physics III	10 units
33-231	Physical Analysis	10 units
33-232	Mathematical Methods of Physics	9 units
33-234	Quantum Physics	10 units
33-331	Physical Mechanics I	10 units
33-338	Intermediate Electricity and Magnetism I	10 units
88-439	Intermediate Electricity and Magnetism II	10 units
33-340	Modern Physics Lab	10 units
33-341	Thermal Physics	10 units
33-201	Physics Sophomore Colloquium I (fall)	2 units
33-202	Physics Sophomore Colloquium II (spring)	2 units
33-301	Physics Upper Class Colloquium I (fall)	1 unit
33-302	Physics Upper Class Colloquium II (spring)	1 unit
21-259	Calculus in Three Dimensions	9 units

Physics Electives (2 courses, 18 units)

Two courses to be approved by the Physics Department.

33-xxx	Physics Electives - two courses	18-21 units
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(33-114 Physics of Musical Sound (9 units) is highly recommended for students with a Music focus)

(33-228 Electronics (10 units) is highly recommended for students seeking practical applications of physics)

III. College of Fine Arts Concentration

(number of courses vary, 108 units minimum)

BSA students choose one of the following concentrations:

- Architecture
- Art
- Design
- Drama
- Music

ARCHITECTURE CONCENTRATION (108 units minimum)

Required Courses (54 units minimum)

48-100	Design Fundamentals	12 units
or		

48-095	Architecture for Non-Majors	9 units
48-130	Architectural Drawing I: Tactile Foundation	9 units
48-135	Architectural Drawing II: Appearance	9 units
48-240	Survey of World Architecture & Urbanism	9 units
48-34x	Architectural History Lecture (varying topics)	9 units
48-44x	Architectural History Lecture (varying topics)	9 units

Complete one of the following Elective Foci, or design your own focus in consultation with the Architecture advisor (54 units minimum):

Elective Focus: General Education in Architecture (54 units)

48-120	Computer Modeling I	9 units
48-210	Statics (prerequisite: 33-106)	9 units
48-215	Materials and Assembly (prerequisite: 48-210)	9 units
48-217	Structures I (prerequisite: 48-210)	9 units
48-230	Drawing III: Perspective (prerequisite: 48-135)	9 units
48-315	Environment I: Climate and Energy (prerequisite: 33-106)	9 units
48-351	Human Factors in Architecture	9 units
48-34x	Architectural History Lecture (varying topics)	9 units
48-44x	Architectural History Lecture (varying topics)	9 units
48-452	Real Estate Design and Development	9 units
48-453	Urban Design	9 units
48-551	Ethics and Decision Making in Architecture	9 units
48-5xx	Departmental Elective (prerequisites vary)	9 units

Elective Focus: Architectural Representation and Visualization (54 units)

This sequence is intended to develop particular skills in architectural representation.

48-120	Introduction to Digital Media I	9 units
48-125	Introduction to Digital Media II	9 units
48-230	Architectural Drawing III: Perspective (prerequisite: 48-135)	9 units
48-563	Building Virtual Worlds	9 units
48-7xx	Graduate Elective	9 units
48-7xx	Graduate Elective	9 units

Elective Focus: Architectural Technology (Six varying topics, 54 units)

This sequence is intended to develop intellectual links to the technical aspects of the profession.

Prerequisite Courses:

21-120	Differential and Integral Calculus	10 units
33-106	Physics I for Engineering Students	12 units
or		
48-115	Physics for Architecture	9 units

Elective Courses:

48-210	Statics (prerequisite: 33-106 or 48-115)	9 units
48-215	Materials and Assembly (prerequisite: 48-210)	9 units
48-217	Structures (prerequisite: 48-210)	9 units
48-315	Environment I: Climate and Energy (prerequisite: 33-106 or 48-115)	9 units
48-410	Environment II: Space, Sound, and Light (prerequisite: 33-106 or 48-115)	9 units
48-412	Environment III: Mechanical Systems	9 units
48-415	Advanced Building Systems (prerequisite: 48-315)	9 units
48-4xx	Designated Departmental Technical Elective	9 units

Elective Focus: Architectural History (six varying topics, 54 units)

48-34x/44x	Architectural History	9 units
48-34x/44x	Architectural History	9 units
48-34x/44x	Architectural History	9 units
48-34x/44x	Architectural History	9 units
48-34x/44x	Architectural History	9 units
48-34x/44x	Architectural History	9 units

ART CONCENTRATION (108 units minimum)

PORTFOLIO REVIEW REQUIRED FOR ADMISSION

Concept Studios (2 courses, 20 units)

Complete two courses:

60-101	Concept Studio I	10 units
60-102	Concept Studio II	10 units
60-201	Concept Studio III	10 units

Media Studios (3 courses, 30 units)

Complete three courses:

60-150	2-Dimensional Studio I	10 units
60-151	2-Dimensional Studio II	10 units
60-250	2-Dimensional Studio III	10 units
60-251	2-Dimensional Studio IV	10 units
60-130	3-Dimensional Studio I	10 units
60-230	3-Dimensional Studio II	10 units
60-110	Electronic Media Studio I	10 units
60-202	Concept Studio: EcoArt	10 units

Advanced Studios (4 courses, 40 units)

Complete four courses. Courses may be offered in the fall and/or spring. Students may take courses in any media area (ETB, PDP or SIS). They may take all courses in one media area if a focus is desired.

60-410-29	Advanced Electronic and Time-Based Work (ETB)	10 units
60-430-49	Advanced Sculpture, Installation and Site-Work (SIS)	10 units
60-450-98	Advanced Painting, Drawing and Printmaking (PDP)	10 units
60-499	Studio- Independent Study (one only)	10 units

Art History/Theory (2 courses, 18 units)

60-205	Modern Visual Culture: 1789-1945	9 units
60-206	Contemporary Visual Culture: 1945 to the Present	9 units

NOTE: To complete the full three-semester historical sequence, take 60-105, Pre-Industrial Visual Cultures, 9 units.

Review Requirement (Complete 2 required reviews, 0 units)

A review is required at the end of the sophomore and senior years. Pass/fail only.

60-200	Sophomore Review (Spring)
60-400	Senior Review (Spring)

DESIGN CONCENTRATION (108 units minimum)

PORTFOLIO REVIEW REQUIRED FOR ADMISSION

Design Required Courses (81 units)

51-101	Design Studio I (Fall)	9 units
51-102	Design Studio II (Spring)	9 units
51-121	Design Drawing I (Fall)	9 units
51-122	Design Drawing II (Spring)	9 units
51-132	Introduction to Photo Design (Spring)	9 units
51-171	Human Experience in Design (Fall)	9 units
51-174	History of Objects and Images (Spring)	9 units
51-271	Design History I (Fall)	9 units
51-272	Design History II (Spring)	9 units
64-100	Critical Histories of the Arts	9 units

Design Electives (27 units)

Choose three (3) additional Design courses in consultation with the Design advisor.

DRAMA CONCENTRATION (108 units minimum)

AUDITION/INTERVIEW REQUIRED FOR DIRECTING OR DRAMATURGY OPTIONS, PORTFOLIO REVIEW/INTERVIEW REQUIRED FOR DESIGN OR PRODUCTION TECHNOLOGY AND MANAGEMENT OPTIONS.

Options available in the following areas: 1) Production Technology and Management, 2) Dramaturgy, 3) Directing, 4) Design

There is no BHA/BSA/BCSA acting or musical theatre option.

The BHA/BSA/BCSA Drama candidate must choose from the four options offered by The School of Drama and successfully pass the audition/interview for Directing or Dramaturgy Options, or the portfolio review/interview for the Design or Production Technology and Management Options. All BHA/BSA/BCSA students are required to take courses 54-177 and 54-179 Foundations of Drama I and II, 54-151 and 54-152 Stagecraft, and 54-175 and 54-176 Conservatory Hour in the freshman year, 54-259 or 54-262 Production Preparation II in one of the semesters of the sophomore year (4-8 weeks per term), and 54-281 and 54-282 Foundations of Drama III and IV during junior or senior year.

Drama Required Courses: (46 units)

54-177, 54-179 Foundations of Drama I and II (freshman year, 6 units per semester) 12 units

54-281, 54-282 Foundations of Drama III and IV (taken anytime from sophomore to senior year, in sequence, 6 units per semester) 12 units

(Note: All Foundations courses are one-semester courses)

54-151, 54-152 Stagecraft

(Includes work on production run-crews and a large classroom component. This is a time-intensive course. BHA/BSA students can modify this commitment in terms of hours and units in consultation with the Drama advisor. Minimum 5 units for classroom work, 6 units for production work. Taking the full 15 units in the fall and 11 units in the spring is recommended but not required.) 11 units minimum

54-259 or 54-262 Production Preparation II (sophomore year, fall or spring semester) 9 units

54-175, 54-176 Conservatory Hour (freshman year, 1 unit per semester, two semesters) 2 units

Drama Electives: (62 units)

Choose additional courses from the Drama catalogue in consultation with the Drama advisor, given the appropriate prerequisites are in place and with permission of instructors where necessary.

MUSIC CONCENTRATION (108 units minimum)

AUDITION AND INTERVIEW REQUIRED FOR MUSIC CONCENTRATION OPTION. INTERVIEW REQUIRED FOR MUSIC HISTORY AND CULTURE OR MUSIC TECHNOLOGY CONCENTRATION OPTION.

Options available in the following areas: 1) Music (instrumental, piano, organ, composition, voice), 2) Music History and Culture, 3) Music Technology.

Required Courses for All Concentration Options

57-152	Harmony I	6 units
57-173	Survey of Western Music History	9 units
57-189	Repertoire and Listening for Musicians I	3 units

Music

Required:

57-xxx	BHA/BSA Studio (4 semesters)	36 units
57-xxx	Major Ensemble (4 semesters)	24 units
57-161	Eurhythmics I	3 units
57-181	Solfege I	3 units

Choose 24 units from:

57-153	Harmony II	6 units
57-283	Music History I	9 units
57-284	Music History II	9 units
57-289	Repertoire and Listening for Musicians III*	3 units
57-290	Repertoire and Listening for Musicians IV*	3 units
57-162	Eurhythmics II	3 units

57-163	Eurhythmics III	3 units
57-164	Eurhythmics IV	3 units
57-182	Solfege II	3 units
57-183	Solfege III	3 units
57-184	Solfege IV	3 units

Music History and Culture

Required:

57-283	Music History I	9 units
57-284	Music History II	9 units
57-289	Repertoire and Listening for Musicians III*	3 units
57-290	Repertoire and Listening for Musicians IV*	3 units
57-611	Independent Study in Music History	6 units

Choose 36 units from:

57-209	Beatles	9 units
57-457	Jazz History I	6 units
57-458	Jazz History II	6 units
57-202	Opera History	9 units
57-477	Music and the Spirit	6 units
57-480	History of Black American Music	6 units

Choose 24 additional Music units in consultation with the Music advisor.

Music Technology

Required:

57-181	Solfege I	3 units
57-101	Introduction to Music Technology	6 units
57-347	Electronic and Computer Music	6 units
57-337	Sound Recording	6 units
57-xxx	Independent Study in Music Technology or Sound Recording	9 units

Choose 36 units from:

57-153	Harmony II	6 units
57-338	Sound Editing and Mastering	6 units
57-438	Multitrack Recording	9 units
57-283	Music History I	9 units
57-284	Music History II	9 units
57-289	Repertoire and Listening for Musicians III*	3 units
57-290	Repertoire and Listening for Musicians IV*	3 units
57-182	Solfege II	3 units

Choose 24 additional Music units in consultation with the Music advisor.

*co-requisite for Music History I and II

IV. Free Electives: 32-44 units

Take any Carnegie Mellon course. A maximum of 9 units of physical education and/or military science may be counted toward this requirement. Physical education and military science courses will not be calculated in a student's QPA.

Bachelor of Computer Science and Arts Degree Program

Sponsored by the School of Computer Science and the College of Fine Arts
Office: Margaret Morrison Carnegie Hall, Room 107
www.cmu.edu/interdisciplinary

Carnegie Mellon University recognizes that there are students who are naturally gifted in both the fine arts and computer science. In order to accommodate students who want to pursue an education simultaneously in these areas, we offer a degree that combines the strengths of the College of Fine Arts (CFA) and the School of Computer Science (SCS). The intercollege degree, called the Bachelor of Computer Science and Arts (BCSA), is a rigorous program that offers a unique group of qualified students the opportunity to develop their talents and interests in an area of the fine arts and an area of computer science.

The BCSA curriculum is divided into three parts: 1) BCSA Core requirements, 2) CFA concentration coursework, and 3) SCS concentration coursework.

Students choose their fine arts concentration from among the five schools in CFA: Architecture, Art, Design, Drama or Music. A student must meet the entry requirements for the particular CFA school of their choice. While in the BCSA Program, a student may change their CFA concentration only if they pass all admission requirements for that particular school.

The BCSA Degree Program is governed by faculty and administrators from both colleges and led by the director of the BHA, BSA, & BCSA Programs. The director and associate director of the BHA, BSA, and BCSA Programs are the primary advisors and liaisons between CFA and SCS. Students receive extensive advising support. Each student has two additional academic advisors: an advisor in the admitting school of CFA for their fine arts concentration, and an advisor in SCS for their computer science concentration. This network of advisors guides each student through their curriculum.

Senior Research/Project Course Option

The BCSA program offers a senior project option. The creation and completion of such a project can be an important integrative and fulfilling capstone. It can also provide an academic goal for BCSA "sub-seniors," as well as influence the development of the BCSA program as a distinguished scholarly and creative undergraduate student community.

BCSA Curriculum

I. BCSA Core	108 units
II. SCS Concentration	122 units
III. CFA Concentration	108 units
IV. BCSA Free Electives	42 units
BCSA Degree Requirements	380 units

I. BCSA Core (12 courses, 108 units minimum)

- Writing/Expression (1 course, 9 units, 76-101 required)
- Research Seminars: 1) BHA, BSA, & BCSA Freshman Research Seminar (1 course, 9 units, 62-190 required) 2) Art, Science, and Technology in Context and Society (1 course, 10 units, 62-xxx required)
- Cultural Analysis (1 course, 9 units minimum)
- Mathematics (2 courses, 20 units, 21-120 and 21-122, or 21-241 required), Probability (1 course, 12 units required)
- Science (2 courses, 18 units)
- Engineering (In consultation with your academic advisor, an engineering course could substitute for one of the two Science requirements)
- Economic, Political, & Social Institutions *OR* Cognition, Choice & Behavior (1 course, 9 units minimum)
- One additional course from one of the following departments: English, History, Modern Languages, Philosophy, or Psychology (1 courses, 9 units)
- University Requirement: Computing @ Carnegie Mellon (1 mini-course, 3 units, to be completed in first semester)

Writing/Expression (1 course, 9 units)

Broadly considered, language is a tool used to communicate, as well as a way to organize non-visual and non-mathematical thinking. This requirement focuses on the social nature of language and the ways in which writing constitutes thinking.

76-101 Interpretation and Argument - REQUIRED

If a score of 5 is obtained on the either English Advanced Placement examination, approved English substitutions at the 200 and 300 level are available.

Research Seminars (2 courses, 19 units)

Freshman Research Seminar (1 course, 9 units)

This course introduces freshmen and sophomore students in the Bachelor of Humanities and Arts (BHA), Bachelor of Science and Arts (BSA), and Bachelor of Computer Science and Arts (BCSA) Programs to research methodology. It examines the two main paradigms that form the basis of research in various fields of inquiry: 1) the systematic, scientific, or positivist approach, and 2) the qualitative, ethnographic, and ecological or naturalistic approach. This course is taught by the director with the participation of guest lecturers when appropriate.

62-190 BHA, BSA, & BCSA Freshman Research Seminar - REQUIRED

Art, Science, and Technology in Context and Society
(1 course, 10 units)

This course comprises five modules – each devoted to a specific theoretical and applicable topic in the arts, science, and technology. Topics include game design, computer animation, computer music, recording techniques, interactive stagecraft, robotic art, and other emerging media. Each module is taught by a specialist and coordinated by the program's director.

62-410 Art, Science, and Technology in Context and Society - REQUIRED

Cultural Analysis (1 course, complete 9 units minimum)

This category explores definitions of culture and the role culture plays in producing different actions and institutions as well as the roles of institutions, systems and human actions in shaping cultural contexts. Listed below are examples of courses that meet the requirement for this category.

57-173	Survey of Western Music History
76-227	Comedy
66-250	Introduction to Religion
70-342	Managing Across Cultures
76-227	Comedy
76-232	African-American Studies
76-241	Introduction to Gender Studies
79-104	Introduction to World History
79-113	Culture and Identity in American Society
79-201	Introduction to Anthropology
79-206	Development of American Culture
79-207	Development of European Culture
79-209	Theory and Practice in Anthropology
79-218	The Roots of Rock & Roll
79-241	African-American History I
79-242	African-American History II
79-368	Poverty, Charity, and Welfare
79-384	Medicine and Society
80-100	What Philosophy Is
80-151	God in the West
80-250	Ancient Philosophy
80-251	Modern Philosophy
80-253	Continental Philosophy
80-254	Analytical Philosophy
80-255	Pragmatism
80-261	Aesthetics of Mass Art
82-3xx	Any 300 level or greater course from Modern Languages

Mathematics & Probability (3 courses, 32 units)

Choose two mathematics courses (20 units):

21-120	Differential & Integral Calculus
21-122	Integration, Differential Equations, and Approximation
or	
21-241	Matrix Algebra

Choose one probability course (12 units):

15-359	Probability and Computing
15-325	Probability
15-217	Probability Theory and Random Processes
15-225	Introduction to Probability and Statistics I
36-625	Probability and Mathematical Statistics I

Science (2 courses, 18 units)

Choose two courses from the following list:

03-121	Modern Biology
09-105	Introduction to Modern Chemistry
21-259	Calculus in Three Dimensions
33-111	Physics for Science Students I

Engineering

In consultation with your academic advisor, an engineering course could substitute for one of the two Science requirements.

Economic, Political & Social Institutions *Or* Cognition, Choice & Behavior (1 course from either category, complete 9 units minimum)

Economic, Political & Social Institutions

This category examines the ways in which institutions organize individual preferences and actions into collective outcomes using model-based reasoning.

36-303	Sampling, Surveys, and Society
70-332	Business and Society
70-420	Entrepreneurship for Scientists
73-100	Principles of Economics
79-223	Protest and Dissent in American History
79-331	Crime and Punishment
79-335	Drug Use and Drug Policy
79-340	History of Modern Warfare
79-345	American Environmental History: Critical Issues
79-350	Theories of International Relations
79-384	Medicine and Society
80-135	Introduction to Political Philosophy
80-136	Social Structure, Public Policy, Ethical Dilemmas
80-235	Political Philosophy
80-236	Philosophy and the Law
80-243	Environment Management and Ethics
80-245	Medical Ethics
80-341	Computers, Society, and Ethics
88-104	Decision Processes in American Political Institutions
88-110	Experiments with Economic Principles
88-205	Comparative Politics
99-226	Rachel Carson: Her Work and Legacy
99-305	The Year is 1905: $E=mc^2$ Photons and Relativity

Cognition, Choice, and Behavior

This category use model-based analysis to broaden an understanding of human thinking, choices, and behavior on an individual basis across a variety of settings.

80-130	Introduction to Ethics
80-150	Nature of Reason
80-180	The Nature of Language
80-181	Language and Thought
80-220	Philosophy of Science
80-221	Philosophy of Social Science
80-230	Ethical Theory
80-241	Ethical Judgments in Professional Life
80-242	Conflict, Dispute Resolution
80-270	Philosophy of Mind
80-271	Philosophy and Psychology
85-100	Introduction to Intelligence in Humans, Animals and Machines
85-102	Introduction to Psychology
85-211	Cognitive Psychology
85-221	Principles of Child Development
85-241	Social Psychology
85-251	Personality
85-261	Abnormal Psychology
88-120	Reason, Passion, and Cognition

Complete ONE additional course from one of the following departments: English, History, Modern Languages, Philosophy, or Psychology

(1 course, complete 9 units minimum)

University Requirement (1 mini-course, 3 units)

This is a mini-course, pass/no credit, to be completed in the 1st semester.

99-10x Computing @ Carnegie Mellon (99-101, 99-102, 99-103)

II. SCS Concentration

SCHOOL OF COMPUTER SCIENCE CONCENTRATION
(122 units minimum)

Computer Science Core Requirements (56 units)

15-111	Intermediate/Advanced Programming	10 units
15-123	Effective Programming in C and Unix (Prerequisite for 15-213)	9 units
15-128	Freshman Immigration Course	1 unit
15-211	Fundamental Data Structures and Algorithms	12 units
15-212	Principles of Programming	12 units
or		
15-213	Introduction to Computer Systems	12 units
15-251	Great Theoretical Ideas in Computer Science	12 units

Concepts of Mathematics (9 units)

21-120	Differential and Integral Calculus	10 units
21-121	Integration and Differential Equations (Prerequisite: 21-115)	10 units
21-127	Concepts of Mathematics (Prerequisite for 15-211)	9 units

Applications Courses or CS Electives
(5 courses, 57 units minimum)

Choose a minimum of five courses from the following list:

15-312	Foundations of Programming Languages	12 units
15-313	Foundations of Software Engineering (Prerequisite for 15-413)	12 units
15-322	Introduction to Computer Music	9 units
15-323	Music Systems and Information Processing [NOT ON SCHEDULE]	
05-331	Building Virtual Worlds [NOT ON SCHEDULE]	
15-381	Artificial Intelligence: Representation and Problem Solving	9 units
15-384	Robotic Manipulation	12 units
15-385	Computer Vision	9 units
15-415	Database Applications	12 units
15-437	Web Application Development	12 units
15-451	Algorithm Design and Analysis	12 units
15-462	Computer Graphics	12 units
15-463	Computational Photography	9 units
15-464	Technical Animation	12 units
15-465	Animation Art and Technology	12 units
15-466	Computer Game Programming	12 units
15-482	Human Language Technologies	12 units
16-362	Mobile Robot Programming Laboratory	12 units

Others as appropriate with advisor's permission.

III. College of Fine Arts Concentration

(number of courses vary, 108 units minimum)

BCSA students choose one of the following concentrations:

- Architecture
- Art
- Design
- Drama
- Music

ARCHITECTURE CONCENTRATION (108 units minimum)

Required Courses (54 units minimum)

48-095	Architecture for Non-Majors (Spring)	9 units
or		
48-100	Architecture Design Studio: Form	12 units
48-130	Architectural Drawing I: A Tactile Foundation	6 units
48-135	Architectural Drawing II: Appearance	9 units
48-240	Survey of World Architecture & Urbanism	9 units
48-34x	Architectural History Lecture (varying topics)	9 units
48-44x	Architectural History Lecture (varying topics)	9 units

Complete one of the following Elective Foci, or design your own focus in consultation with the Architecture advisor (54 units minimum)

Elective Focus: General Education in Architecture (54 units)

48-120	Introduction to Digital Media I	9 units
48-210	Statics (prerequisite: 33-106 or 48-115)	9 units
48-215	Materials and Assembly (prerequisite: 48-210)	9 units
48-217	Structures (prerequisite: 48-210)	9 units
48-230	Architectural Drawing III: Perspective (prerequisite: 48-135)	9 units
48-315	Environment I: Climate and Energy (prerequisite: 33-106 or 48-115)	9 units
48-351	Human Factors in Architecture	9 units
48-34x	Architectural History Lecture (varying topics)	9 units
48-44x	Architectural History Lecture (varying topics)	9 units
48-452	Real Estate Design and Development	9 units
48-453	Urban Design	9 units
48-551	Ethics and Decision Making in Architecture	9 units
48-5xx	Departmental Elective (prerequisites vary)	9 units

Elective Focus: Architectural Representation and Visualization (54 units)

This sequence is intended to develop particular skills in architectural representation.

48-120	Introduction to Digital Media I	9 units
48-125	Introduction to Digital Media II	6 units
48-230	Architectural Drawing III: Perspective (prerequisite: 48-135)	9 units
48-7xx	Graduate Elective	9 units
48-7xx	Graduate Elective	9 units

Elective Focus: Architectural Technology (Six varying topics, 54 units)

This sequence is intended to develop intellectual links to the technical aspects of the profession.

Prerequisite Courses:

21-114	Calculus for Architects	5 units
33-106	Physics I for Engineering Students	12 units
or		
48-115	Physics for Architects	9 units

Elective Courses:

48-210	Statics (prerequisite: 33-106 or 48-115)	9 units
48-215	Materials and Assembly (prerequisite: 48-210)	9 units
48-217	Structures (prerequisite: 48-210)	9 units
48-315	Environment I: Climate and Energy (prerequisite: 33-106 or 48-115)	9 units
48-410	Environment II: Space, Sound, and Light (prerequisite: 33-106 or 48-115; in conjunction with studies)	6 units
48-412	Environment III: Mechanical Systems	9 units
48-415	Advanced Building Systems (prerequisite: 48-315; in conjunction with studies)	6 units
48-4xx	Designated Departmental Technical Elective	9 units

Elective Focus: Architectural History (Six varying topics, 54 units)

48-34x/44x	Architectural History	9 units
48-34x/44x	Architectural History	9 units
48-34x/44x	Architectural History	9 units
48-34x/44x	Architectural History	9 units
48-34x/44x	Architectural History	9 units
48-34x/44x	Architectural History	9 units

ART CONCENTRATION (108 units minimum)

PORTFOLIO REVIEW REQUIRED FOR ADMISSION

Concept Studios (2 courses, 20 units)

Complete two courses:

60-101	Concept Studio I (Fall)	10 units
60-102	Concept Studio II (Spring)	10 units
60-201	Concept Studio III (Fall)	10 units
60-xxx	Concept Studio: EcoArt or other	10 units

Media Studios (2 courses, 20 units)

Complete two courses:

60-150	2D Media Studio I: Drawing (Fall)	10 units
60-151	2D Media Studio II: Drawing (Spring)	10 units
60-250	2D Media Studio III: Painting (Fall, Spring)	10 units
60-251	2D Media Studio IV: Printmaking (Spring)	10 units
60-130	3D Media Studio I: Wood, Welding, Clay (Spring)	10 units
60-230	3D Media Studio II: Foundry, Metals, Mixed Media (Fall)	10 units
60-110	Electronic Media Studio I: Computer Art (Fall)	10 units
60-210	Electronic Media Studio II	10 units

Advanced Media Studios (6 courses, 60 units)

Complete six courses. Courses may be offered in the fall and/or spring. Students may take courses in any media area (ETB, PDP or SIS). They may take all courses in one media area if a focus is desired.

60-410-29	Advanced Electronic and Time-Based Work (ETB)	12 units
60-414	Adv. ETB: Animation Art & Technology	12 units
60-414	Adv. ETB: Animation	10 units
60-418	The Interactive Image	10 units
60-423	Audio Visual Systems and Machines	10 units
60-430-49	Adv. Sculpture, Installation & Site-Work (SIS)	10 units
60-450-98	Advanced Painting, Drawing and Printmaking (PDP)	10 units
60-499	Studio - Independent Study (one only)	10 units

Art History/Theory (2 courses, 18 units)

60-205	Modern Visual Culture: 1789-1945	9 units
60-206	Contemporary Visual Culture: 1945-Present	9 units

NOTE: To complete the full three-semester historical sequence, take 60-105, Pre-Industrial Visual Cultures, 9 units.

Review Requirement (Complete 2 required reviews, 0 units)

60-200	Sophomore Review (Spring)
60-400	Senior Review (Spring)

NOTE: A review is required at the end of the sophomore and senior years. Pass/fail only.

DESIGN CONCENTRATION (108 units minimum)

PORTFOLIO REVIEW REQUIRED FOR ADMISSION

Design Required Courses (81 units)

51-101	Design Studio I (Fall)	9 units
51-102	Design Studio II (Spring)	9 units
51-121	Design Drawing I (Fall)	9 units
51-122	Design Drawing II (Spring)	9 units
51-132	Introduction to Photo Design (Spring)	9 units
51-171	Human Experience in Design (Fall)	9 units
51-271	Design History I (Fall)	9 units
51-272	Design History II (Spring)	9 units
64-100	Critical Histories of the Arts	9 units

Design Electives (27 units)

Choose three (3) additional Design courses at the sophomore, junior and senior levels in consultation with the Design advisor.

DRAMA CONCENTRATION (145 units minimum)

PORTFOLIO REVIEW & INTERVIEW REQUIRED FOR PRODUCTION TECHNOLOGY & MANAGEMENT (PTM)

PTM is the only option available to BCSA candidates.

Drama PTM Required Courses: (133 units minimum)

54-177, 54-178	Foundations of Drama I and II (freshman year, 6 units per semester)	12 units
54-281, 54-282	Foundations of Drama III and IV (taken anytime from sophomore to senior year, in sequence, 6 units per semester)	12 units

(Note: All Foundations courses are one-semester courses)

54-151, 54-152	Stagecraft	15 + 11 units
54-157, 54-158	Basic PTM	12 units
54-169, 54-170	Studiocraft	13 + 8 units
54-266	Technical Management	6 units
54-250	Stagecraft II	14 units

54-271	Scenic Fabrication and Install	6 - 18 units
54-273	Technical Direction I	6 - 21 units
54-333, 54-334	Production Management I	6 - 21 units
54-475	Theatre Management	6 units

Drama Electives: (12 units minimum)

Choose additional courses from the following list in consultation with the Drama PTM advisor.

54-366	Physics of Stage Machinery	9 units
54-368	Production Electrics	4 - 18 units
54-378	Technical Direction II	6 - 21 units
54-477	Technical Direction III	6 - 26 units
54-xxx	Technical Direction IV	6 - 26 units
54-453, 54-456	Production Mgmt. Workshop	3 - 23 units

MUSIC CONCENTRATION (108 units minimum)

AUDITION AND INTERVIEW REQUIRED FOR ADMISSION TO THE MUSIC COMPOSITION CONCENTRATION OPTION. INTERVIEW REQUIRED FOR ADMISSION TO THE MUSIC TECHNOLOGY CONCENTRATION OPTION.

OPTIONS AVAILABLE IN THE FOLLOWING AREAS: 1) COMPOSITION, 2) MUSIC TECHNOLOGY

Required Courses for Both Concentration Options

57-152	Harmony I	6 units
57-173	Survey of Western Music History	9 units
57-189	Repertoire and Listening for Musicians I	3 units

Composition Required Courses:

Required:

57-xxx	BHA/BSA Studio (4 semesters)	36 units
57-xxx	Major Ensemble (4 semesters)	24 units
57-161	Eurhythmics I	3 units
57-181	Solfege I	3 units

Choose 24 units from:

57-153	Harmony II	6 units
57-162	Eurhythmics II	3 units
57-163	Eurhythmics III	3 units
57-164	Eurhythmics IV	3 units
57-182	Solfege II	3 units
57-183	Solfege III	3 units
57-184	Solfege IV	3 units
57-283	Music History I	9 units
57-284	Music History II	9 units
57-289	Repertoire and Listening for Musicians III *	3 units
57-290	Repertoire and Listening for Musicians IV *	3 units

Music Technology Required Courses:

57-101	Introduction to Music Technology	6 units
57-181	Solfege I	3 units
57-337	Sound Recording	6 units
57-347	Electronic and Computer Music	6 units
57-xxx	Independent Study in Music Technology or Sound Recording	

Choose 36 units from:

57-153	Harmony II	6 units
57-182	Solfege II	3 units
57-283	Music History I	9 units
57-284	Music History II	9 units
57-289	Repertoire and Listening for Musicians III *	3 units
57-290	Repertoire and Listening for Musicians IV *	3 units
57-338	Sound Editing and Mastering	6 units
57-438	Multitrack Recording	9 units

Choose 24 additional Music units in consultation with the Music advisor.

*co-requisite for Music History I and II

IV. Free Electives: 42 units

Take any Carnegie Mellon course. A maximum of 9 units of physical education and/or military science may be counted toward this requirement. Physical education and military science courses will not be calculated in a student's QPA.

Bachelor of Science in Computational Finance

The Mellon College of Science, the Heinz School of Public Policy and Management and the Tepper School of Business jointly offer a degree uniquely designed to meet the quantitative needs of the finance industry. Modeled after the highly successful Carnegie Mellon Master of Science in Computational Finance, this degree allows students to develop a deep knowledge of mathematics, probability, statistics, and the applications of these disciplines to finance. Students who complete this degree may directly enter the finance industry, enter other industries where an applied mathematics training is appropriate, or pursue advanced degrees in economics, finance or the mathematical sciences. Students entering the work force upon completion of this degree may wish to later complement their undergraduate degree with a Master's degree in Business Administration or other professional degree. Students who might eventually pursue doctoral degrees in economics, finance, statistics or mathematics should seek advising on how to use their electives in order to prepare for graduate work in their chosen disciplines. Students apply for admission to the B.S. program in Computational Finance in the second semester of the sophomore year. Later application is also possible.

The Bachelor of Science in Computational Finance is an Intercollegiate Program. Students who pursue Computational Finance as their primary major may elect to have either the Mellon College of Science (MCS) or the Tepper School of Business (Tepper) as their home college. The coursework required for the major is the same in either case, with one minor exception outlined below. The general education requirements for the degree depend on the student's home college. MCS students must complete the same Humanities, Social Sciences, and Fine Arts requirements as other MCS students. In addition, MCS students are required to take two science courses, one fewer than other MCS majors. Tepper students must complete the Breadth Requirements of the Undergraduate Business Administration Program. Additionally, they must take several courses from the Functional Business Core of that program.

Majors in Computational Finance can tailor their degree program by selecting Depth Electives aligned with their interests and ambitions. MCS students are required to take four depth electives. Tepper students must take three depth electives and 70-391 Finance (MCS students may select 70-391 as one of their four depth electives).

MCS Science Requirements

Students intending to apply to the B.S. program in Computational Finance should follow the science curriculum outlined below. Specifically, students should take two semesters of calculus, 21-120 Differential and Integral Calculus and 21-122 Integration, Differential Equations and Approximation; and 15-100 Introductory/Intermediate Programming.

In addition, in the freshman year students should complete two of the following three courses:

33-111	Physics I for Science Students
03-121	Modern Biology
09-105	Introduction to Modern Chemistry

MCS Humanities, Social Sciences & Fine Arts Requirements

Candidates for the B. S. in Computational Finance must complete 72 units offered by the College of Humanities and Social Science and/or the College of Fine Arts. Of these 72 units, 36 are specified by the detailed curriculum in below. These are:

76-101	Interpretation and Argument
73-150	Principles of Economics with Calculus
73-200	Microeconomics
73-251	Economic Theory

Two of the remaining four courses must be in specific categories as listed in the section on general requirements for a Bachelor's degree in the Mellon College of Science. One in Category 1: Cognition, Choice and Behavior, and one in Category 3: Cultural Analysis.

Tepper Functional Business Core

The Functional Business Core of the Undergraduate Business Administration Program includes 70-122 Introduction to Accounting, which is required by all Computational Finance majors. It also includes 70-391, which Tepper students majoring in Computational Finance must take in place of one Depth Elective. In addition, Tepper students pursuing the B.S. in Computational Finance must complete six other courses from the Functional Business Core.

These courses are:

70-100	Introduction to Business
70-311	Organizational Behavior
70-332	Business Society and Ethics
70-371	Production and Operations Management
70-381	Marketing
70-401	Management Game

Tepper Breadth Requirements

Candidates for the B.S. in Computational Finance must complete the breadth requirements outlined in the section describing the Undergraduate Business Administration Program.

Depth Electives

The detailed curriculum below includes four depth electives. These are to be chosen from among the following:

21-355	Principles of Real Analysis I
21-365	Projects in Applied Mathematics
21-372	Partial Differential Equations
36-401	Modern Regression
36-402	Topic in Data Analysis
36-461	Statistics Topic
70-391	Finance
70-393	Financial Analysis and Securities Trading
70-398	International Finance
70-492	Investment Analysis
70-495	Corporate Finance
70-497	Options
73-252	Advanced Macroeconomic Theory
73-253	Advanced Macroeconomic Theory
73-372	International Money and Finance
73-392	Financial Economics
73-420	Monetary Theory and Policy

MCS Detailed Curriculum

What follows is the detailed curriculum for the degree Bachelor of Science in Computational Finance in the Mellon College of Science. The courses listed are required. The semesters in which the courses are to be taken are suggested.

Freshman Year

	Fall	Units
15-100	Introductory/Intermediate Programming	10
21-120	Differential and Integral Calculus	10
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
xx-xxx	Science Requirement	9-12
		41-44
	Spring	
15-200	Advanced Programming/Practicum	9
21-122	Integration, Differential Equations and Approximation	10
70-122	Introduction to Accounting	9
73-150	Principles of Economics with Calculus	9
xx-xxx	Science Requirement	9-12
xx-xxx	Elective	9
		46-49

Sophomore Year

	Fall	Units
21-241	Matrix Algebra (or 21-341 Linear Algebra I)	9
21-259	Calculus in Three Dimensions	9
21-260	Differential Equations	9
73-100	Principles of Economics	9
xx-xxx	Humanities, Social Science or Fine Arts Elective	9
		45
	Spring	
21-270	Introduction to Mathematical Finance	9
21-292	Operations Research I	9
21-369	Numerical Methods	9
73-150	Microeconomics	9
xx-xxx	Elective	9
		45

Junior Year

	Fall	Units
21-325	Probability	9
21-370	Discrete-Time Finance	9
73-200	Macroeconomics	9
xx-xxx	Depth Elective	9
xx-xxx	Elective	9
		45
	Spring	
21-420	Continuous-Time Finance	9
36-226	Introduction to Probability and Statistics II	9
36-410	Introduction to Probability Models	9
xx-xxx	Humanities, Social Science or Fine Arts Elective	9
xx-xxx	Depth Elective	9
		45
	Fall	Units
45-816	Studies in Financial Engineering	6
90-718	Strategic Presentation Skills	6
90-729	Organizational Design and Implementation	6
xx-xxx	Depth Elective	9
xx-xxx	Humanities, Social Science or Fine Arts	9
xx-xxx	Elective	9
		45-48
	Spring	
90-717	Strategic Writing Skills	6
xx-xxx	Depth Elective	9
xx-xxx	Humanities, Social Science or Fine Arts Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	0-6
		42-48

Tepper Detailed Curriculum

What follows is the detailed curriculum for the degree Bachelor of Science in Computational Finance in the Tepper School of Business. The courses listed are required. The semesters in which the courses are to be taken are suggested.

Freshman Year

	Fall	Units
15-100	Introductory/Intermediate Programming	10
21-120	Differential and Integral Calculus (or 21-122)	10
70-100	Introduction to Business	9
73-100	Principles of Economics	9
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
		50
	Spring	
15-111	Intermediate/Advanced Programming	9
21-122	Integration, Differential Equations and Approximation	10
21-241	Matrix Algebra	9
73-150	Microeconomics	9
xx-xxx	Breadth Course	9
xx-xxx	Breadth Course	9
		55

Sophomore Year

	Fall	Units
21-259	Calculus in Three Dimensions	9
21-260	Differential Equations	9
21-325	Probability	9
70-122	Introduction to Accounting	9
73-200	Macroeconomics	9
		45
	Spring	
21-270	Introduction to Mathematical Finance	9
21-292	Operations Research I	9
36-226	Introduction to Probability and Statistics II	9
70-311	Organizational Behavior	9
70-381	Marketing	9
		45

Junior Year

	Fall	Units
21-370	Discrete-Time Finance	9
70-391	Finance	9
xx-xxx	Depth Elective	9
xx-xxx	Breadth Course	9
xx-xxx	Elective	9

45

	Spring	Units
21-420	Continuous-Time Finance	9
21-369	Numerical Methods	9
36-410	Introduction to Probability Models	9
70-371	Production and Operations Management	9
xx-xxx	Breadth Course	9

45

Senior Year

	Fall	Units
45-816	Studies in Financial Engineering	6
70-322	Business, Society and Ethics	9
70-401	Management Game	12
xx-xxx	Depth Elective	9
xx-xxx	Breadth Course	9

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	Spring	Units
90-717	Strategic Writing Skills	6
90-718	Strategic Presentation Skills	6
xx-xxx	Depth Elective	9
xx-xxx	Breadth Course	9
xx-xxx	Breadth Course	9
xx-xxx	Elective	9

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The Computational Finance Minor

The requirements for the Computational Finance Minor are listed below. Beginning in Fall 2006, a student must satisfy one of the following requirements to declare a minor:

1. Completion of 21-270 Introduction to Mathematical Finance with a grade of A and an overall QPA of at least 3.2.
or
2. Completion of 21-270 Introduction to Mathematical Finance and 21-370 Discrete-Time Finance with an average grade of B and an overall QPA of at least 3.0.

When a student has met the necessary requirements, he or she may declare the minor by contacting the Associate Dean of the Mellon College of Science.

21-241	Matrix Algebra (or 21-341 Linear Algebra I)
21-259	Calculus in Three Dimensions (or 21-256 Multivariate Calculus)
21-260	Differential Equations
21-270	Introduction to Mathematical Finance
21-370*	Discrete-Time Finance
21-420**	Continuous-Time Finance

To avoid excessive double counting, Mathematical Sciences majors must also take 21-365 Projects in Applied Mathematics or an approved substitute.

*Pre-requisite for 21-370, 21-270 and either 21-256 or 21-259, and the co-requisite is 70-207, 21-325, 36-225 or 36-217.

** Pre-requisite for 21-420 is 21-260, 21-370 and one of the following three calculus based probability courses: 21-325, 36-225 or 36-217. Note that 70-207 is not a sufficient preparation in probability. Also note that 21-122 is a prerequisite for 21-260 and that 21-127 is a prerequisite for 21-341 and is recommended for 21-241.

Students minoring in Computational Finance are strongly encouraged to take one or two economics course, e.g., 73-100, 73-150, or 73-200.

Science and Humanities Scholars Program

Sponsored by the College of Humanities and Social Sciences and the Mellon College of Science
Dr. William Alba, Director
Office: Doherty Hall, Room 2201
www.cmu.edu/shs

The Science and Humanities Scholars (SHS) program is for students who wish to build upon a solid academic foundation in the humanities, social sciences, natural sciences, and mathematics. Students in this program enroll in either the Mellon College of Science (MCS) or the College of Humanities and Social Sciences (H&SS). While every student at the university may elect to pursue multi- and interdisciplinary studies, the SHS General Education curriculum assures that students in the program can develop the background for any field of study or combination of studies across both MCS and H&SS.

SHS students in their first year may elect to live in a Stever House residential cluster that promotes the integration of academic and social interests. As upperclass students, they are eligible to live in upperclass housing reserved for interdisciplinary students and may continue to participate in occasions that foster their intellectual community. The program additionally supports students through the creation of interdisciplinary and multidisciplinary courses.

Before a student declares a major, the program director serves as the student's primary academic advisor, complementing the range of other advising available around the university. After a student declares a major, the director continues to provide supplementary advising for the student, especially on matters of General Education.

Entering first-year students with outstanding credentials who applied to H&SS or MCS may receive an invitation to the SHS Program. Those invited should carefully consider whether this academic program matches their own scholarly interests. Students enrolled in either college may also request to transfer into the Science and Humanities Scholars Program after completing at least one semester at the university.

Science and Humanities Scholars General Education Program

There are 14 requirements in the SHS General Education Program. The curriculum is designed to expose students to a variety of subjects and methodologies, in order to enable them to become better citizens of the world and more complete scholars with a comprehensive range of possible major choices. The SHS curriculum allows for flexibility and independence in selecting courses to fulfill these General Education requirements, and in many cases students in the Program can petition the Director to take alternate courses in addition to the ones listed here.

Mathematical Sciences (29 units)

1. 21-120 Differential and Integral Calculus or 21-131 Analysis I
2. 21-122 Integration, Differential Equations, and Approximation or 21-132 Analysis II
3. 36-247 Statistics for Lab Sciences (or appropriate substitute)

Writing/Expression (9 units)

Language is a tool used to communicate, as well as a way to organize thinking. This university-wide requirement, to be completed in the first year, focuses on the social nature of language and the ways in which writing constitutes thinking.

4. 76-101 Interpretation & Argument

World Cultures (9 units)

This requirement seeks to enable students to recognize how cultures have shaped and continue to shape the human experience, as well as analyze material that provide clues as to how these cultures operate.

5. 79-104 Introduction to World History

Freshman Seminar (6-9 units)

6. Students may select an SHS seminar, a full-semester seminar from H&SS, or two half-semester freshman seminars from MCS and/or H&SS from a list of courses provided every semester.

Computational Reasoning (9-10 units)

7. Choose from the following courses

15-100	Introductory / Intermediate Programming
15-111	Intermediate / Advanced Programming
21-127	Concepts of Mathematics
80-210	Logic and Proofs
80-211	Logic and Mathematical Inquiry
80-212	Arguments and Logical Analysis

Science Core (28 units)

8-10. Choose three of the following courses. Science majors must take at least two that are outside their major and in different departments.

03-121	Modern Biology
03-130	Introduction to Mammalian Physiology
09-105	Introduction to Modern Chemistry
or	
09-107	Honors Chemistry
09-106	Modern Chemistry II
33-111	Physics I for Science Students
or	
33-131	Matter and Interactions I
33-112	Physics II for Science Students
or	
33-132	Matter and Interactions II

Distribution Requirements (36 units)

11-14. Choose a minimum of four courses, at 9 units per category, totaling at least 36 units. Below are examples of courses satisfying these categories. You are encouraged to identify other courses that could fulfill these requirements; see the SHS Director for prior approval.

Cognition, Choice, and Behavior

11. Courses in this category use model-based analysis to broaden an understanding of human thinking, choices, and behavior on an individual basis across a variety of settings.

80-130	Introduction to Ethics
80-150	Nature of Reason
80-180	Nature of Language
80-181	Language and Thought
80-221	Philosophy of Social Science
80-230	Ethical Theory
80-241	Ethical Judgments in Professional Life
80-242	Conflict and Dispute Resolution
80-270	Philosophy of Mind
80-271	Philosophy and Psychology
85-100	Introduction to Intelligence in Humans, Animals and Machines
85-102	Introduction to Psychology
85-211	Cognitive Psychology
85-221	Principles of Child Development
85-241	Social Psychology
85-251	Personality
85-261	Abnormal Psychology
88-120	Reason, Passion, and Cognition

Economic, Political, and Social Institutions

12. Courses in this category examine the ways in which institutions organize individual preferences and actions into collective outcomes using model-based reasoning.

36-303	Sampling, Surveys, and Society
70-332	Business and Society
73-100	Principles of Economics
73-150	Microeconomics
79-223	Protest and Dissent in American History
79-266	Times of Feast/Famine: Population and Family in History
79-331	Crime and Punishment
79-335	Drug Use and Drug Policy
79-340	History of Modern Warfare
79-345	American Environmental History: Critical Issues
79-350	Theories of International Relations
80-135	Introduction to Political Philosophy
80-136	Social Structure, Public Policy, and Ethical Dilemmas
80-235	Political Philosophy
80-236	Philosophy and the Law
80-243	Environment Management and Ethics
80-341	Computers, Society, and Ethics
88-104	Decision Processes in American Political Institutions
88-184	Topics of Law: The Bill of Rights
88-205	Comparative Politics

Creative Production and Reflection

13. Courses in this category encourage exploration of the artistic and intellectual creation of others while allowing for personal expression and reflection upon the creative process.

xx-xxx	Courses from the College of Fine Arts (Architecture 48-xxx, Design 51-xxx, Drama 54-xxx, Music 57-xxx, Art 60-xxx, CFA Interdisciplinary 62-xxx)
76-260	Survey of Forms: Fiction
76-262	Survey of Forms: Nonfiction
76-265	Survey of Forms: Poetry
76-269	Survey of Forms: Screenwriting
80-120	Reflections on Science
80-220	Philosophy of Science
80-260	Philosophy of Art
82-1xx	Any Elementary Modern Language course
82-2xx	Any Intermediate Modern Language course
99-241	Revolutions of Circularity

Cultural Analysis

14. Courses in this category explore definitions of culture and the role culture plays in producing different actions and institutions, as well as the roles of institutions, systems, and human actions in shaping cultural contexts.

57-173	Survey of Western Music History
66-250	Introduction to Religion
70-342	Managing Across Cultures
76-227	Comedy
76-232	African-American Studies
76-241	Introduction to Gender Studies
79-113	Culture and Identity in American Society
79-201	Introduction to Anthropology
79-206	Development of American Culture
79-207	Development of European Culture
79-209	Theory and Practice in Anthropology
79-218	The Roots of Rock & Roll
79-241	African-American History I
79-242	African-American History II
79-260	Mayan America
79-270	Chinese Culture and Society
79-312	Medical Anthropology
79-368	Poverty, Charity, and Welfare
79-384	Medicine and Society
80-100	What Philosophy Is
80-151	God in the West
80-250	Ancient Philosophy
80-251	Modern Philosophy
80-253	Continental Philosophy
80-254	Analytical Philosophy
80-255	Pragmatism
80-261	Aesthetics of Mass Art
82-273	Introduction to Japanese Language & Culture
82-294	Topics in Russian Language and Culture
82-303	French Culture
82-304	Francophone World
82-325	Introduction to German Studies
82-333	Introduction to Chinese Language & Culture
82-342	Spain: Language and Culture
82-343	Latin America: Language and Culture
82-344	US Latinos: Language and Culture
82-345	Hispanic Literary and Cultural Studies
82-396	The Faust Legend
82-415	Studies in French Literature
82-426	Studies in German Literature
82-451	Introduction to Latin American Literature
82-491	Literature, Politics, and Film in Russia and East Europe Today

Major Programs

A number of majors that reflect the interdisciplinary nature of research and teaching between the physical and natural sciences, humanities, mathematics, and social/behavioral sciences have been introduced, or are under development, inspired in part by the SHS program. Two are presented here (in Biological Sciences and Psychology, and in Mathematical and Statistical Sciences) and are now available to students.

The Major in Mathematical and Statistical Sciences (B.S.)

This degree program is administered under the joint Science & Humanities Scholars Program between the Mellon College of Science and the College of Humanities & Social Sciences. To qualify, a student must be acceptable for admission to both colleges.

Mathematical Sciences: 85 Units

21-120 Differential and Integral Calculus
 21-122 Integration, Differential Equations, and Approximation
 21-127 Concepts of Mathematics
 21-241 Matrix Algebra
 21-259 Calculus in Three Dimensions
 21-201 Undergraduate Colloquium
 21-292 Operations Research I
 21-355 Principles of Real Analysis I
 or
 21-369 Numerical Methods
 21-xxx Mathematical Science Elective
 21-xxx Mathematical Science Elective

Probability and Statistics: 36 Units

21-325 Probability
 or
 36-225 Introduction to Probability and Statistics I

Note: 21-325 Probability is preferred.

36-226 Introduction to Probability and Statistics II
 36-410 Introduction to Probability Models
 36-461 Undergraduate Seminar

Data Analysis: 27 Units

36-247 Statistics for Laboratory Sciences
 36-309 Experimental Design for Behavioral and Social Sciences
 or
 36-303 Surveys, Sampling & Society
 36-401 Advanced Data Analysis I

Statistics and Data Analysis Electives: 18 Units

Complete two courses from the following:

21-393 Operations Research
 36-402 Advanced Data Analysis II
 36-462 Applied Multivariate Methods

In consultation with his/her advisor, the student may also arrange to take Statistics graduate courses (36-7xx) to satisfy part of this requirement.

Joint MCS/H&SS Core other than Mathematical Science or

Statistics courses: 103-107 Units

Free Electives:
 Enough to reach 360 Units

Sample Course Sequence: Math & Statistical Sciences

Freshman Year: Fall

21-120 Differential and Integral Calculus
 21-127 Concepts of Mathematics
 76-101 Interpretation and Argument
 33-111 Physics for Science Students I
 99-10x Computing @ Carnegie Mellon

Freshman Year: Spring

21-122 Integration, Differential Equations, and Approximation
 36-247 Statistics for Laboratory Sciences
 79-104 World History
 xx-xxx Science
 xx-xxx Freshman Seminar

Sophomore Year: Fall

21-201 Undergraduate Colloquium
 21-241 Matrix Algebra
 36-309 Experimental Design
 xx-xxx Economic, Political and Social Institutions
 xx-xxx Science
 xx-xxx Elective

Sophomore Year: Spring

21-201 Undergraduate Colloquium
 21-259 Calculus in Three Dimensions
 21-292 Operations Research I
 xx-xxx Cultural Analysis
 xx-xxx Electives

Junior Year: Fall

21-355 Principles of Real Analysis I
 21-325 Probability
 xx-xxx Cognition, Choice and Behavior
 xx-xxx Electives

Junior Year: Spring

21-xxx Mathematical Science Elective
 36-226 Introduction to Probability and Statistics II
 36-410 Introduction to Probability Models
 xx-xxx Creative Production & Reflection
 xx-xxx Electives

Senior Year: Fall

21-393 Operations Research II
 36-401 Advanced Data Analysis I
 36-461 Undergraduate Seminar
 xx-xxx Electives

Senior Year: Spring

21-xxx Mathematical Science Elective
 36-402 Advanced Data Analysis II
 36-xxx Senior Research Elective
 xx-xxx Electives

Major in Psychology & Biological Sciences

This unified major is intended to reflect the interdisciplinary nature of our current research in the fields of Psychology and Biology, as well as the national trend in some professions to seek individuals broadly trained in both the social and natural sciences. Students entering from the College of Humanities and Social Sciences will earn a Bachelor of Science in Psychology and Biological Sciences. Students entering from the Mellon College of Sciences receive a Bachelor of Science in Biological Sciences and Psychology. Students entering from the Joint Science and Humanities Scholars (SHS) program can complete the SHS educational core and choose either departmental order for their diploma.

Specific Pre-Major Requirements

The unified major specifies particular pre-major requirements in the areas of Mathematical Sciences and Statistics, Natural Science, and Computational Reasoning. Particular courses are specified in these areas because they are prerequisites for courses required in the major and therefore they are the most efficient way to complete the general education requirements for either HSS or SHS. All other general education categories can be filled in any way that satisfies the requirements of the student's college of the SHS programs.

Mathematical Sciences/Statistics

21-120 Differential Calculus and Integral Calculus
 21-122 Integration & Differential Equations and Calculus of Approximations
 36-247 Statistics for Laboratory Sciences*
 36-309 Experimental Design for Behavioral and Social Sciences

* 36-201 can be used as an alternative, but 36-247 is strongly encouraged.

Natural Sciences

09-105 Introduction to Modern Chemistry
 09-106 Modern Chemistry II
 33-xxx Physics I for Science Students
 09-217 Organic Chemistry I
 09-218 Organic Chemistry II

Computational Reasoning

99-10x Computing @ Carnegie Mellon
 15-100 Introductory/Intermediate Programming

Discipline Core Requirements

Biological Sciences

03-121	Modern Biology
03-231	Biochemistry
03-240	Cell Biology
03-330	Genetics

Psychology

85-102	Introduction to Psychology
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Complete three of the following courses (85-219 should be included as one of the three):

85-211	Cognitive Psychology
85-213	Human Information Processing and Artificial Intelligence
85-219	Biological Foundations of Behavior
85-221	Principles of Child Development
85-241	Social Psychology
85-251	Personality

NOTE: Students can also take four Survey courses, one of which should be 85-219 Biological Foundations of Behavior.

Laboratory/Research Methods Requirements

09-221	Chemistry Laboratory I
09-222	Chemistry Laboratory II
03-343	Experimental Genetics and Molecular Biology

Research Methods in Psychology

Complete one of the following:

85-310	Research Methods in Cognitive Psychology
85-320	Research Methods in Developmental Psychology
85-340	Research Methods in Social Psychology

Prerequisite for all Research Methods courses: 36-309, and corresponding psychology survey course.

(Note: 36-309 may be taken concurrently as a co-requisite)

Additional Laboratory Requirement:

Complete one additional laboratory experience either as an additional 85-xxx Research Methods course in Psychology or a second laboratory in Biological Sciences at the 300 level or above.

Advanced Psychology/ Biological Sciences Electives

54 units

1. Psychology Advanced Elective 1
2. Psychology Advanced Elective 2
3. Biology General Elective
4. Biology Advanced Elective 1 (03-360 recommended)
5. Biology Advanced Elective 2
6. Advanced Biological Sciences or Psychology Elective, 85-3xx or higher (Research recommended)

Additional comments:

If a student drops the unified major program, a second Research Methods course would be required to complete the B.S. in Psychology. If a student drops the unified major program, the following additional courses would be required to complete the B.S. in Biological Sciences: 09-214 Physical Chemistry, 33-xxx Physics II and a second, 300-level Biology laboratory course. This program does not satisfy all of the requirements for pre-medical preparation. Advising is suggested to determine the additional courses needed for that program.

The Undergraduate Additional Major in Human-Computer Interaction

Robert Kraut, Undergraduate Advisor

Office: Newell Simon Hall (NSH) 3515

For up to date information, see: www.hcii.cs.cmu.edu/Academics/Undergrad/undergrad.html

Overview

Human-Computer Interaction (HCI) is a fast growing field devoted to the design, implementation, and evaluation of interactive computer-based technology. Examples of HCI products include intelligent computer tutors, wearable computers, social networking sites, and internet connected personal digital assistants (PDAs). Constructing an HCI product is a cyclic, iterative process that has at least three stages: Design, Implementation, and Evaluation.

The Design stage involves principles of design and human behavior, the Implementation stage principles of computer science, and the Evaluation stage empirical research methods common to several disciplines. There are thus four topical areas to cover in this major: Human Behavior, Design, Implementation, and Evaluation. In slightly more detail, the major involves the following sorts of knowledge and skill:

Design

- Eliciting from the client, formulating, and articulating functional specifications
- Knowing how human factors and cognitive models should inform design
- Knowing the principles of, and having experience with, communication design
- Understanding how implementation constraints should inform design
- Incorporating evaluation results into iterated designs

Implementation Programming Skills

- Standard programming languages - e.g., C++, Java
- Rapid prototyping skill (e.g., Visual Basic, Flash)
- Computational literacy, i.e., knowledge sufficient for effective communication and decision making about:
 - interface construction tools and languages
 - multimedia authoring tools
 - data structures and algorithms
- Operating systems, platforms, etc.

Evaluation

- Experimental design
- Focus Groups
- Surveys
- Usability Testing (Cognitive walkthroughs, user models, heuristic evaluation, GOMS)
- Statistical Analysis

There are over 45 courses relevant to these areas that are now offered by eight different departments in four different colleges at Carnegie Mellon (the School of Computer Science, the College of Humanities and Social Sciences, and the College of Fine Arts, and the Tepper School of Business).

Curriculum

Required Courses:

85-211	Cognitive Psychology
or	
85-213	Human Information Processing and Artificial Intelligence
15-100	Introductory/Intermediate Programming
05-430	
or 431	Programming Usable Interfaces
51-261	Communication Design Fundamentals
51-421	Basic Interaction Design
05-410	Introduction to Human-Computer Interaction Method
05-571	Project Course

Statistics Requirement:

The Statistics requirement can be satisfied by taking any of the following one or two semester courses, or by receiving credit for courses taken elsewhere.

36-201	Statistical Reasoning, Statistical Methods
or	
36-247	Statistics for Lab Sciences

- or
 36-220 Engineering Statistics and Quality Control
 or
 36-225
 & 226 Introduction to Probability and Statistics I and II
 or
 36-207 Prob. and Statistics for Business Applications

Evaluation Requirement:

The Evaluation requirement can be satisfied by taking any of the following courses, or by receiving credit for courses taken elsewhere.

- 36- 303 Sampling, Surveys, and Society
 36- 208 Regression Analysis
 36- 309 Experimental Design for Behavioral & Social Science
 85- 310 Research Methods in Cognitive Psychology
 85- 340 Research Methods in Social Psychology
 88- 250 Regression Methods in the Social Sciences?
 88- 251 Empirical Research Methods
 70- 481 Marketing Research

Electives (18 Units):

From the following list, or by permission from the major advisor:

Design

- 51-132 Introduction to Photographic Design
 51-202 Introduction to Typography
 51-222 Color and Communication
 51-241 How People Work
 51-242 How Things Work
 51-251 Digital Prototyping
 51-424 Web Portfolio
 51-414 Integrated Product Development
 76-481 Writing for Multi-media
 76-479 Computers and Writing ?
 76-487 On-line Information Design
 76-491 Planning and Testing Documents ?
 80-291 Issues in Multimedia Authoring

Computer Science

- 15-211 Fundamental Data Structures and Algorithms
 15-212 Principles of Programming
 15-462 Computer Graphics
 15-499 Media Technology ?
 15-880 Speech Recognition ?
 70-459 Distributed Virtual Business

HCI

- 05-320 Social Web
 05-831 Building Virtual Worlds
 05-395 Applications of Cognitive Science
 05-410 Computer Supported Cooperative Work
 05-411 Cognitive Crash Dummies
 05-413 Human Factors
 05-430 Programming Usable Interfaces
 05-431 Software Architecture for User Interfaces
 05-432 Cognitive Modeling and Intelligent Tutoring Systems
 05-540 Rapid Prototyping of Computer Systems

Human Behavior

- 45-392 Human Behavior in Organizations
 45-453 Organizational uses of information systems
 85-370 Perception
 85-412 Production System Models of Thought
 85-417 Intelligent Computer-Assisted Instruction
 88-367 Computers and Organizations
 70-311 Organization Behavior
 70-451 Management Information Systems

Multimedia

- 80-291 Issues in Multimedia Authoring
 76-382 Multimedia Authoring I
 76-383 Multimedia Authoring II
 76-481 Writing for Multimedia

Double Counting

All prerequisites can be double counted with any requirements in your primary major. At most three non-prerequisite courses can be double counted with the primary major and the HCI second major. For example, if you are majoring in Cognitive Psychology, then you might want to take 85-211 (Intro to Cognitive Psychology) as one of your three double counts. If more than three of the requirements are already in your primary major, then you must add electives until you have eight HCI courses not required as part of your primary major.

Accelerated Master's Programs

The HCI Institute currently offers a three semester (12-month), 15 course Masters in HCI. Undergraduates who have taken the core courses, and an elective on the 400 level or above will be considered eligible for the Accelerated Masters program. These students, which include all undergraduate HCI majors, can apply for the Accelerated Masters program by November 1st of their Senior year, and can begin the Masters program in the Spring of their Senior year. They can finish the Masters degree after the Summer and Fall.

Admission to the Major

The HCI undergraduate major is currently available only as a second major. Because space is limited in the major's required courses, enrollment in the HCI undergraduate major is currently limited to 25 students in each graduating class. 6 with a primary major in Design, 6 in H&SS, 6 in SCS, and 7 anywhere. Applications are processed once a year, during Spring Break. For more detail, see the website: www.hcii.cs.cmu.edu/Academics/Undergrad/undergrad.html

The Minor in Health Care Policy and Management**Sponsored by:**

H. John Heinz III School of Public Policy and Management
 College of Humanities and Social Sciences
 Mellon College of Science

Faculty Advisors:

Caroline Acker, College of Humanities and Social Sciences
 Brenda Peyser, H. John Heinz III School of Public Policy and Management, Amy Burkert, Mellon College of Science

The face of health care is changing. The practice of medicine is being fundamentally altered by the forces of change in public policy, health care organizations and in the industry as a whole. The role of individual professionals in this industry is changing as rapidly as the industry itself. Traditional career paths have disappeared overnight to be replaced by new opportunities that require new skills. New organizations are placing new demands on their professional and medical staffs. The criteria of efficiency and financial stability are entering the domains of diagnosis and treatment.

This minor is designed to provide students considering a career in the health professions with an understanding of how these changes are likely to affect their careers. Students will become familiar with the critical policy and management issues and will begin to learn to operate effectively in the emerging health care environment. The curriculum combines economic, organizational, managerial, historical and psychological perspectives on these issues to provide a foundation for a deepened understanding of the changing structure of health care organizations and policy.

Curriculum (minimum) 60 units

Seven courses (a minimum of 60 units) are required to complete this minor. Entry into the minor requires completion of 73-100, Economics or 88-220, Policy Analysis I or the equivalent by approval.

Required Courses 33 units

Students are required to take the following courses.

- 79-384 Medicine and Society (9 units)
 90-735 Health Economics (12 units)
 90-836 Health Systems (6 units)
 90-861 Health Policy I (6 units)

Elective Courses 27 units
Complete a minimum of 27 units.

Heinz School Courses

91-830	Financial Management of Health Systems
91-836	Legal Issues in Health Systems Management
91-844	Managing Quality Improvement
91-853	Health Care Information Systems
91-xxx	Health Policy II
91-862	Managed Care

Humanities and Social Sciences Courses (9 units each)

76-494	Healthcare Communications
79-335	Drug Use and Drug Policy
79-336	Epidemic Disease and Public Health
80-245	Medical Ethics
80-247	Health, Development, and Human Rights
85-241	Social Psychology
85-442	Health Psychology
85-446	The Psychology of Gender

Please note that some of these courses have prerequisites that will not count toward the completion of the requirements for this minor.

Bachelor of Science in Computational Biology

Computational Biology is concerned with solving biological and biomedical problems using mathematical and computational methods. It is recognized as an essential element in modern biological and biomedical research. There have been fundamental changes in biology and medicine over the past decade due to spectacular advances in biomedical imaging, genomics, and proteomics. The nature of these changes demands the application of novel theories and advanced computational tools to decipher the implications of these data, and to devise methods of controlling or modifying biological function. Consequently, Computational Biologists must be well trained and grounded in biology, mathematics, and computer science.

The School of Computer Science and Mellon College of Science have joined forces to establish an exciting new interdisciplinary program leading to a B.S. in Computational Biology. This new degree is a major re-engineering of the current Computational Biology major offered by the department of Biological Sciences (which was one of the first degree-granting program in Computational Biology in the country). This new degree supplants the old program beginning in 2006.

The goal of this new degree program is to provide an intensive interdisciplinary education to enable outstanding students to become leaders in identifying and solving tomorrow's biological problems using computational methods. The new program's curriculum, which can be found on the web at <http://www.cs.cmu.edu/~mjs/cb-curriculum.html> is truly interdisciplinary and is designed for students interested in the intersection of Biology and Computer Science.

Applications to the program are invited from current sophomores. Applicants must have completed, or be currently enrolled in: 03-231, Biochemistry I and 15-211, Fundamental Data Structures and Algorithms. Applicants must submit an informal transcript (whiteprint, obtainable from their academic advisor) and an essay describing their interest in the program. Completed applications should be submitted to Dr. Amy Burkert at ak11@andrew.cmu.edu in Doherty Hall 1320 or Dr. Mark Stehlik at mjs@cs.cmu.edu in Wean Hall 5103 no later than the end of October.

Degree Requirements

Math/Stats Core

		Units
21-120	Differential and Integral Calculus	10
21-122	Integration, Diff Equations, and Approximation	10
21-127	Concepts of Mathematics	9
21-XXX	Math Elective (21-241, 21-260, 21-341)	9
36-XXX	Statistics Elective (36-217, 36-225, 36-247, 36-625)	9

Total Units 47

General Science Core

09-105	Intro to Modern Chemistry	10
09-106	Modern Chemistry II	10
09-217	Organic Chemistry I	9
33-111	Physics for Science Students I	12

Total Units 41

Biological Sciences Core

03-121	Modern Biology	9
03-231/232	Biochemistry	9
03-240	Cell Biology	9
03-330	Genetics	9
03-342	Introduction to Biological Laboratory Practices +	
03-343	Experimental Genetics and Molecular Biology	13
03-201	Colloquium or	
15-128	Immigration	1
03-411	Topics in Research	1

Total Units 51

Computer Science Core

15-111	Intermediate/Advanced Programming	10
15-123	Effective Programming in C and UNIX	9
15-211	Fundamental Data Structures and Algorithms	12
15-251	Great Theoretical Ideas in Computer Science I	12
15-451	Algorithm Design and Analysis	9

Total Units 52

Major Electives

03-510	Computational Biology or	
03-511	Computational Molecular Biology and Genomics	9-12
03-xxx/ 15-xxx	2 Computational Biology Electives	18-24
03-3XX	Advanced Biology Elective	9
15-XXX	Advanced Computer Science Elective (15-211 or higher)	9
15- ALG	Fundamentals of Algorithms Course	9

Total Units 45-54

General Education

99-10x	Computing @ Carnegie Mellon	3
76-101	Interpretation and Argument	9
Elective	Cognition, Choice and Behavior	9
Elective	Economics, Political and Social Institutions	9
Elective	Cultural Analysis	9
Elective	Non-technical Elective	9

Total Units 75

Free Electives

Elective	Free Elective	40 - 49
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Minimum number of units required for degree: 360



Carnegie Institute of Technology



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Carnegie Institute of Technology

Pradeep Khosla, Dean
Kurt Larsen, Assistant Dean for Undergraduate Studies
Office: Scaife Hall 110
<http://www.cit.cmu.edu/>

Carnegie Institute of Technology, the engineering college of the university, has three main activities - undergraduate education, graduate education, and research. Its continuing goal has been to maintain excellence in all these activities. The degree to which this goal has been achieved is attested to by the demand for its graduates, the success of its alumni, the quality of its students and faculty, the adoption elsewhere of its innovations, and the national and international recognition it receives in educational and research activities.

The college offers the degree of bachelor of science in chemical engineering, civil engineering, electrical and computer engineering, mechanical engineering, and materials science and engineering. All of these programs are accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET). An engineering student may also choose to pursue a minor in one of the CIT designated minor programs, or a double major in engineering and public policy or biomedical engineering, or to design minor, additional major or dual-degree programs with other non-engineering departments.

Educational Objectives

The overarching objective of our engineering curriculum is to provide our students an education that enables them to be productive and fulfilled professionals throughout their careers. Our more specific, measurable objectives for graduates of our engineering curriculum are the following:

- Graduates recognize that they acquired a high quality, rigorous technical education from the College of Engineering at Carnegie Mellon.
- Graduates, in addition to their technical knowledge, recognize that they have acquired a broader body of knowledge that allows them to understand the larger context of the problems that they must address during their career.
- Graduates use their technical foundation and their broader base of knowledge to be successful in a diverse collection of individual careers inside and outside of the engineering profession.

From its earliest days, Carnegie Institute of Technology (CIT) has considered undergraduate education to be the key element in the development of future leaders. In this regard, CIT has adopted a plan for education that is designed to equip students with the capacity to learn and to continue the process of self-education throughout their lives. The present curriculum incorporates this philosophy by providing the opportunity for both breadth in a number of engineering, science, humanities and fine arts areas as well as depth in a major area of concentration. To achieve these goals, our flexible curriculum has been designed to allow students to customize their program to suit their needs and to help each student acquire:

- A thorough and integrated understanding of fundamental knowledge in fields of a students' major interest and the ability to use this knowledge;
- Competence in the orderly way of thinking, which professionals and scientists have always used in reaching sound, creative conclusions, with the goal that after graduation the student can, by such thinking, reach decisions both as a professional and as a citizen;
- An ability to learn independently with scholarly orderliness, so that after graduation the student will be able to grow in wisdom and keep abreast of the changing knowledge and problems of the profession and the society in which he or she participates;
- The philosophical outlook, breadth of knowledge, and sense of values which will increase the student's understanding and enjoyment of life and enable each student to recognize and deal effectively with the human, economic, ethical and social aspects of professional problems; and
- The ability to communicate ideas to others in a comprehensive and understandable manner.

The curriculum encourages students to confront professional problems, accomplished through team and problem-oriented

courses, as well as courses which emphasize design or individual projects. These classes stress creativity and independent thought and require the student to define the problem, propose a solution or a design in the presence of technical and socioeconomic constraints, to make judgments among alternative solutions, and to explore innovative alternatives to more conventional solutions.

First Year for Engineering Students

The Carnegie Mellon engineering education is based on engineering and science fundamentals that give students the skills to face new and challenging situations. The first year in engineering provides a broad foundation upon which students build a curriculum in their eventual major. Since students in CIT do not select a major until the end of the first year, all first year students share a common experience consisting of introductory courses in the engineering majors (one each semester), calculus, physics, other science courses which compliment specific introductory engineering courses, and courses in the College of Humanities and Social Sciences (General Education). This curriculum helps make an informed decision about a final major. Below is an examples of a standard schedule for a first-year engineering student.

Fall Semester	Units
Introductory Engineering Elective	12
Restricted Technical Elective	9-12
Differential and Integral Calculus	10
A Writing/Expression Course	9
Computing @ Carnegie Mellon	3

Spring Semester	Units
Introductory Engineering Elective	12
Restricted Technical Elective	10
Integration, Differential Equations, Approximation	10
General Education Course	9

Notes:

1. Each semester every CIT department offers its Introductory Engineering Elective*. Every first year CIT student must select one such course each semester.
* Except Engineering and Public Policy, offered only in the spring.

2. Restricted Technical Electives include the following courses:

	Units
03-121 Modern Biology	9
09-105 Modern Chemistry I	10
15-100 Introductory/Intermediate Programming	10
or	
15-111 Intermediate/Advanced Programming	10
33-106 Physics for Engineering Students I	12
3. Each Introductory Engineering Elective requires a specific Restricted Technical Elective (to be taken prior to or contemporarily with the Introductory Engineering Elective) chosen from the above set as follows

Introductory Engineering Course	Restricted Technical Elective
Biomedical Engineering	03-121
Chemical Engineering	09-105
Civil & Environmental Engineering	33-106
Electrical & Computer Engineering	15-100 or 15-111
Engineering & Public Policy	33-106
Mechanical Engineering	33-106
Materials Science and Engineering	33-106

4. All students must complete Physics for Engineering Students I by the end of the first year. Therefore, if a student chooses to take Introduction to Chemical Engineering (with 09-105 as a co-requisite) during one semester and Introduction to Electrical and Computer Engineering (with 15-100 as a co-requisite), the student must take 33-106 in place of the General Education requirement in the Spring semester of the first year and take the General Education course in a subsequent semester. Alternatively, a student entering the university with AP credit in a required first year course may substitute 33-106 in its place.

Program in General Education for CIT

Students

Breadth Requirement 27 Units

Humanistic Studies (Cultural Analysis)* 9 units
79-104 Introduction to World History

Cognitions and Institutions* 9 units
73-100 Principles of Economics -or-
85-100 Introduction to Intelligence
88-104 Decision Process in American Political Institutions

* A list of alternative courses for Humanistic Studies and Cognitions and Institutions is available at www.cit.cmu.edu.

Writing/Expression 9 units
76-101 Interpretation and Argument

Depth Sequence in Humanities, Social Science,
or Fine Arts 27 units

A sequence of humanities, social science, or fine arts courses which provides depth in a specific area. Usually, 27 units from a single department meet this requirement. However, related courses from different departments may also satisfy this requirement. At least 9 of these units should be beyond the introductory or elementary level and CFA performance courses, if chosen, must also include theory or history of the subject. A depth sequence in language must include at least three nine-unit courses in the same language. Business Administration, Heinz School, and Statistics Department courses may NOT be used to satisfy this requirement. Although this requirement is typically satisfied by completing 3 courses of at least 9 units each, some acceptable courses are greater or less than 9 units (e.g. 6-unit Art courses). While mini courses of fewer than 9 units may be combined to equal 9 unit courses, the excess units from courses greater 9 units may NOT be used to satisfy this requirement. For example, a 12 unit, 6 unit, 9 unit combination is not acceptable. A 6 unit, 3 unit, 9 unit, 9 unit combination is acceptable.

Non-Technical Electives 18 units

Two unrestricted humanities, social science or fine arts courses. Non-technical courses from Business Administration, or the Heinz School may also satisfy this requirement. Accounting, finance, management, marketing, production, and statistics courses are regarded as technical courses and may NOT be used to satisfy this requirement. Although this requirement is typically satisfied by completing 2 courses of at least 9 units each, some acceptable courses are greater or less than 9 units (e.g. 6-unit Art courses). While mini courses of fewer than 9 units may be combined to equal 9 unit courses, the excess units from courses greater 9 units may NOT be used to satisfy this requirement. For example, a 12 unit, 6 unit combination is not acceptable. A 6 unit, 3 unit, 9 unit combination is acceptable.

Free Elective Courses

A free elective is any graded Carnegie Mellon course. However, a maximum of nine units in the form of pass/fail or non-factorable courses (including physical education, StuCo and military science) may be taken as free electives in most CIT degree programs (Except for ECE).

Additional Majors and Dual Degrees in CIT

A major is defined as a program that must be completed for the granting of a degree. Additional majors comprise a single degree with majors in two separate areas; for example, the degree of Bachelor of Science in Chemical Engineering and an additional major in English. Although the additional major requires the completion of two designated programs, they may have overlapping requirements that can be met simultaneously. The general principle used to measure eligibility for a Carnegie Institute of Technology additional major is that the major (core) requirements of both departments must be completed. Finally, although the student is formally enrolled as an undergraduate in one of the departments (the parent department, which is responsible for scheduling and other administrative actions for the student), the student should apply for the additional major through the second department and coordinate requirements with both departments.

The additional major is to be distinguished from a dual degree program, which results in two separate bachelor's degrees; for

example, Bachelor of Science in Chemical Engineering and a Bachelor of Arts in English. The dual degree, though, requires a minimum of 90 units of work in addition to the units required for the first degree. The second degree may be earned in Bachelor of Science or Bachelor of Arts degree programs.

Requirements for CIT students wishing to complete Additional Majors

The student must satisfactorily pass all requirements of the regular and complete program (with the permissible exceptions) leading to a degree in CIT. The minimum number of units required for the additional major is the number required by the parent department or major.

The student takes and satisfactorily completes the courses specified by a second department, usually using elective space available in the first program.

The second department, on the basis of the specified number of courses plus the courses comprising the parent department's regular degree requirements, then certifies that the student has completed the requirements for a major in the second department.

At the CIT advisor's discretion, equivalent technical electives may be substituted from either MCS or SCS departments.

Non-technical courses in the curricula can be altered to meet the requirements of the second major. But if the second major is not an H&SS department, the program must include a minimum of 72 units of General Education courses to meet CIT requirements for graduation.

Designated Minors Offered by CIT (for engineering students)

In addition to their regular majors for B. S. degrees, undergraduate students in the Carnegie Institute of Technology can elect to complete an interdisciplinary Designated Minor. These minors have been added to the Carnegie Institute of Technology curriculum to promote flexibility and diversity among the college's engineering students. Independent of major, a student is free, but not required, to pursue a selected designated minor from the following list:

- * Automation and Control
 - * Biomedical Engineering*
 - * Colloids, Polymers and Surfaces
 - * Data Storage Systems Technology
 - * Electronic Materials
 - * Engineering Design
 - * Environmental Engineering and Sustainability
 - * International Engineering
 - * Manufacturing Engineering
 - * Material Science and Engineering
 - * Mechanical Behavior of Materials
 - * Robotics (described on the following page)*
- * Also available for non-CIT students

Complete descriptions of the designated minors can be found on p. 89-92. To add a CIT Designated Minor, please go to the CIT Dean's Office (Scaife Hall 110). Contact the director listed under each minor.

Biomedical Engineering Minor

(for non-engineering students)

Todd Przybycien, Director Office: Doherty Hall A-220

General Requirements (five courses, 51-57 units, plus pre- and co-requisite courses including 03-121, Modern Biology). Students must earn a cumulative QPA of 2.00 in these five courses. Double counting of core courses in student's primary major is not permitted.

- Introduction to BHE (42-101) 12 units
- A secondary Introductory Engineering Course 12 units
- BME Elective or Domain* 9-12 units
- BME Elective or Domain** 9-12 units
- BME Elective or Domain** 9-12 units

*Cannot be a course required by your home department).

** Courses marked with an (*) must be offered by any of the CIT Departments (06-xxx, 12-xxx, 18-xxx, 19-xxx, 24-xxx, 27-xxx or 42-xxx)

BME Domain Courses

03-121	Modern Biology
03-240	Cell Biology
03-310	Introduction to Computational Biology
03-311	Computational Molecular Biology
03-330	Genetics
03-343	Experimental Genetics and Molecular Biology
03-344	Experimental Biochemistry
03-345	Experimental Cell and Developmental Biology
03-350	Developmental Biology
03-438	Physical Biochemistry
03-439	Introduction to Biophysics
03-441	Molecular Biology of Prokaryotes
03-442	Molecular Biology of Eukaryotes
03-510	Computational Biology
03-533	NMR in Biomedical Sciences
03-534	Bio Imaging Fluorescence Spectroscopy
09-245	Physical Chemistry II
15-211	Fundamental Structures of Computer Science I
42-301	Physiology
42-377	Rehabilitation Engineering
42-501	Special Topics: Biomaterials I & II
42-560	Research Project (at CMU or UPMC)
42-604	Biological Transport
42-621/06-621	Biotechnology & Environmental Processes
42-622/06-622	Bio Process Design
42-644	Medical Devices
42-651/12-651	Air Quality Engineering
42-652	Introduction to Biomechanics
42-723/12-723	Biological Processes in Environmental Systems

BME Electives

06-607	Phys Chem of Colloids and Surfaces
06-609/09-509	Physical Chemistry of Macromole
06-313 06-313	Exp Colloid Science
06-314	Exp Polymer Science
06-426	Experimental Colloid Surface Science
06-466	Experimental Polymer Science
18-3XX*	
19-607	Special Topics in Biotechnology
24-354	General Robotics
24-779	Human Systems and Control
27-432	Electrical, Magnetic, and Optical Properties of Materials
27-441	Deformation and Fracture of Materials
36-247	Statistics for Lab Sciences
39-319	Law and the Engineer
88-270	Networking: Organizations, Knowledge, and Technology
88-302	Behavioral Decision Making
88-340	Economics of Entrepreneurship in High Technology Industries
90-830	Financial Management of Health System
90-831	Health Management Systems
90-836	Legal Issues in Health Systems Management
90-837	Health Project Planning & Management
90-650	Introduction to Health Care Management
90-853	Health Care Information Systems
90-861	Health Policy

*Since most Electrical and Computer Engineering courses are electives and circuits and signals integral to many medical technologies, a student could use just about any 18-XYZ course where X is greater than 1 and a student can satisfy prerequisites or obtain permission from the instructor.

Engineering Studies Minor

(for non-engineering students)

Kurt Larsen, Director Office: Scaife Hall 110

Carnegie Mellon undergraduate students enrolled in colleges other than engineering can complete a Minor in Engineering Studies in addition to their regular majors. Students pursuing this minor are required to complete courses from at least two different engineering departments in order to assure some breadth of exposure to engineering. In addition, the minor provides students the opportunity to pursue an in-depth concentration in a particular field of engineering.

For the Minor in Engineering Studies, students must complete five engineering courses as follows and must earn a cumulative QPA of 2.00 in these five courses.

Double counting of core courses in student's primary major is not permitted.

1. Two of the following:

06-101	Introduction to Chemical Engineering
12-100	Introduction to Civil and Environmental Engineering
18-100	Introduction to Electrical & Computer Engineering
19-101	Introduction to Engineering & Public Policy
24-101	Introduction to Mechanical Engineering
27-100	Engineering the Materials of the Future
42-101	Introduction to Biomedical Engineering

2. Three courses of at least 9 units each from one or more CIT departments

NOTE: The following courses may NOT be included as part of the Minor in Engineering Studies

12-090	Technology and the Environment
18-200/18-202	Math Foundations of Electrical Engineering
19-319	Law and the Engineer
19-321	Law and Technology
24-160	Engineering Graphics
42-301	Physiology

Although a student generally can complete the minor in Engineering Studies without increasing the number of required units for graduation, early planning in selecting courses is important. Students interested in this minor are encouraged to seek advice in their own home department or college and in the CIT Office of Undergraduate Studies, Scaife Hall 110.

Technology and Policy Minor

(for non-engineering students)

Mark Kieler, Director Office: Baker Hall 129

The Technology and Policy Minor is administered by the Department of Engineering and Public Policy (EPP) for students who are majoring in areas other than engineering or computer science. The T&P Minor is designed to give students a basic understanding of the interactions between technology, society and policy and some project experience in problems involving technology and policy.

The T&P Minor requires satisfactory completion of a set of six courses totaling a minimum of 51 units. These courses are:

19-102	EPP Sophomore Seminar (Fall)	3 units
19-451 or 452	EPP Project (Fall or Spring)	12 units
	(see page 144 for a description of EPP Projects)	
73-100	Principles of Economics (Fall or Spring)	9 units

Two EPP Technical Electives totaling 18 units Page 149 shows examples of EPP technical electives. This is only a representative sample and should not be used for course selection. Always refer to the current list of EPP technical electives. EPP distributes this list prior to registration each semester.

Decision Science Course* 9 units

*Choose one of the following:

88-223	Decision, Analysis & Decision Support Systems (Spring)
88-302	Behavioral Decision Making (Fall)
19-426	Environmental Decision Making (Fall)

Students who are interested in the T&P Minor should contact the Department of Engineering and Public Policy early in their course of study.

Robotics Minor

(for engineering and non-engineering Students)

Howie Choset, Director Office: Scaife Hall 315

As its name suggests, the robotics minor focuses on robotics. It is open to students in all colleges of the University. This minor will have a prerequisite: basic programming skills, and familiarity with basic algorithms. Typically, students get these by taking Introductory/ Intermediate Programming (15-100). Students should be able to demonstrate programming experience from other courses or independent study work.

A central course for the minor is a new one entitled, General Robotics (24-354). This course will give students the big picture of what is going on in robotics through topics such as kinematics, mechanisms, motion planning, sensor based planning, mobile robotics, sensors, and vision. The minor also has two other required courses: (1) a controls class and (2) a manipulation, dynamics, or mechanism class. These courses provide students with the necessary intuition and technical background to move on to more advanced robotics courses.

Students may satisfy the elective requirement by taking an upper level Robotics Institute course and an independent research project under Mechanical Engineering Project (24-391/392), Mechanical Engineering Department Research Honors (24-291/492), CIT Honors (39-500), or Undergraduate Research in Robotics (16-597). In any event, the student must have course selection approved by the director of the minor. In order to be awarded the Minor in Robotics, a student must earn a cumulative QPA of 2.0 in these courses.

Following is the list of courses that must be completed for the Minor in Robotics:

Overview

24-354 General Robotics

One of the following courses:

24-451	Feedback Control Systems
18-370	Fundamentals of Control
06-362	Chemical Engineering Process Control
16-299	Introduction to Controls (Computer Science)

Manipulation, Dynamics, Mechanisms

One of the following courses:

15-384/18-384	Manipulation
24-353	Intermediate Dynamics
24-355 or 24-248	Kinematics and Dynamics of Mechanisms

Electives

Two of the following courses:

24-384	Special Topics in Design: Computational Geometry
15-385	Computer Vision
60-422	Advanced ETB: Robotic Art Studio
16-362/16-862	Introduction to Mobile Robot Programming
24-700/16-735	Robotic Sensor Based Motion Planning
18-778	Mechatronic Design
15-381	Artificial Intelligence: Representation and Problem Solving
15-881/15-499	Introduction to Geometry
85-213	Information Processing and Artificial Intelligence
85-420	Perception and Perceptual Development

One Independent study course

An upper level RI course

Academic Standards

Grading Practices

Undergraduate grading regulations are detailed starting on page 54.

CIT Dean's Honor List

Each semester, Carnegie Institute of Technology recognizes students who have earned outstanding academic records by naming them on the dean's honor list. The criterion for such recognition is a semester quality point average of at least 3.75 while completing at least 36 factorable units and earning no incomplete grades.

Transfer into CIT Departments

Undergraduate students admitted to colleges other than CIT who wish to transfer into a CIT department during their first year should consult with the assistant dean of CIT. Students admitted to CIT but excluded from certain departments must also consult with the assistant dean if they wish to transfer into a restricted CIT department. No first-year student will be considered for transfer until after mid-semester grades for the spring semester have been posted. At that time, a decision will be based on availability of space and the student's academic performance.

CIT undergraduate students beyond the first year wishing to transfer into another CIT department may do so if they are not on academic probation and if there is room in the department of their choice. If the demand for any department exceeds the space available, then the department will admit students based on a comparative evaluation of all applicants at the end of each semester, up to the limit of available space.

Undergraduate students not in CIT who wish to transfer into a CIT department beyond the first year will be considered for transfer on a rolling space available/academic performance basis.

Procedure for transfer of students from another university into CIT departments: A student first applies through the Office of Admission. If the Office of Admission believes the applicant is acceptable, the student's record is sent to the appropriate department for evaluation and a decision on acceptance. The CIT department head has the right to refuse to accept the student if there are space restrictions and/or if the student's chance for success in the CIT department is determined to be questionable based on past academic performance.

Academic Actions

In the first year, a student's quality point average below 1.75 in either semester invokes an academic action. For all subsequent semesters, a student's semester QPA or the cumulative QPA (excluding the first year) below 2.0 invokes an academic action.

Probation

The action of probation occurs in the following cases:

One semester QPA of the first year falls below 1.75.

The semester QPA of a student in good standing beyond the first year falls below 2.00.

The term of probation is one semester as a full-time student. First year students are no longer on probation at the end of the semester if their semester QPA is 1.75 or above. Students in the third or subsequent semester of study are no longer on probation at the end of one semester if the semester QPA AND cumulative QPA (excluding the first year) are 2.00 or above.

Probation Continued

A student who is currently on one semester of probation but whose record indicates that the standards are likely to be met by the end of the next semester may be continued on probation at the discretion of the associate dean.

Suspension

A student who does not meet minimum standards at the end of one semester of probation will be suspended.

A first year student will be suspended if the QPA from each semester is below 1.75.

A student in the third or subsequent semester of study will be suspended if the semester QPA or the cumulative QPA (excluding the first year) is below 2.00 for two consecutive semesters.

The normal period of suspension is one academic year (two semesters). At the end of that period a student may petition to return to school (on probation) by completing the following steps:

1. Writing a formal petition requesting to return and receiving permission in writing from the assistant dean for undergraduate studies.

2. Completing a Return from Leave of Absence form from Enrollment Services; and
3. Providing transcripts and clearance forms if the student has been in a degree program at another college or university even though academic credit earned will not transfer back to Carnegie Mellon.

Students who are suspended, take a leave of absence or withdraw are required to vacate the campus (including residence halls and Greek houses) within a maximum of two days after the action and to remain off the campus for the duration of the time specified. This action includes debarment from part-time or summer courses at the university for the duration of the period of the action.

Drop

This is a permanent severance. A student is dropped when it seems clear that the student will never be able to meet minimum standards. A student who has been suspended and fails to meet minimum standards after returning to school is dropped.

If students are dropped, they are required to vacate campus (including dormitories and fraternity houses) within a maximum of two days after the action. This action includes debarment from part-time or summer courses.

The relation indicated above between probation, suspension, and drop is normal, not binding. In unusual circumstances, College Council may suspend or drop a student without prior probation.

Graduation Requirements

For graduation, students must complete the requirements for their specified degrees with a cumulative quality point average of 2.00 or higher for all courses taken after the freshman year. In addition, a student is expected to achieve a cumulative quality point average of 2.00 in core departmental courses.

Students must be recommended for a degree by the faculty of CIT.

A candidate must meet the residence requirement of having completed at least 180 units at Carnegie Mellon University.

Students must meet all financial obligations to the university before being awarded a degree.

Modification of Graduation Requirements: A student may seek permission to modify graduation requirements by petition to the CIT College Council.

Other Regulations Affecting Student Status

Schedule Changes

(See page 31 for add/drop procedure information and page 56 for grading procedures for dropped courses)

Course Add Deadline

The last date to ADD courses is stipulated for each semester on the university calendar - about two weeks after the beginning of a term. This applies to all courses with the following exception: the final date to add half-semester mini-courses is the last class day of the first week of the course.

Course Drop/Withdraw Deadline

CIT undergraduate students may DROP a course on-line on or before the deadline published in the official university calendar. This deadline is two weeks after mid-semester grades are due in The HUB. The deadline to drop a half-semester mini course is the last day of the fourth week of the mini course. When a course is dropped by the deadlines, the course is removed entirely and disappears from a student's academic record. After the official university deadline to drop, undergraduate students may WITHDRAW from a course on-line on or before the last day of classes, excluding final examinations. The deadline to withdraw from a half-semester mini course is the last class day of the mini course. When a student withdraws from a course between the official university deadline to drop a course and the last day of classes, a "W" (Withdrawal) is assigned as a grade, which appears on the student's academic record. This "W" grade does not affect a student's QPA.

CIT undergraduates who are registered as full time students as of the tenth class day are expected to remain full time for the duration of a semester. Full time is defined by being registered for a minimum of 36 factorable units. Students may not drop or withdraw from courses that will reduce their factorable units below 36 unless there are extenuating circumstances for which they obtain approval from the CIT College Council. Undergraduates who are registered as part time (those carrying fewer than 36 factorable units) as of the 10th class day are also subject to the above deadlines to drop or withdraw from a course.

Exceptions to the regulations above will be granted only upon approval of a petition to the College Council.

Undergraduate Designated Minors in Carnegie Institute of Technology

Undergraduate students in the Carnegie Institute of Technology can elect to complete an interdisciplinary Designated Minor in addition to their regular majors for B.S. degrees. Designated minors have been added to the curriculum of the Carnegie Institute of Technology to promote flexibility and diversity among the college's engineering students. Independent of a student's major, he or she is able to pursue a selected designated minor from the following list:

- * Automation and Control
- * Biomedical Engineering
- * Colloids, Polymers and Surfaces Technology
- * Data Storage Systems Technology
- * Electronic Materials
- * Engineering Design
- * Environmental Engineering
- * International Engineering
- * Manufacturing Engineering
- * Materials Science and Engineering
- * Mechanical Behavior of Materials
- * Robotics (previously described)

An engineering student may elect to complete a CIT designated minor. Generally, the student takes all the required courses in an engineering major but uses electives to take courses needed to fulfill the requirements of the designated minor. Upon completion of the requirements of a CIT designated minor and the engineering degree, the minor is a formally recognized on the student's transcript.

Each of the CIT designated minors is administered by a Program Committee consisting of faculty from all major engineering departments who serve as faculty advisors. Each Program Committee certifies the completion of requirements of the designated minor. But the student's major department is responsible for approving the degree with a designated minor after reviewing a student's entire academic record. Any substitution or departure from the published curriculum should be avoided. For example, non-technical courses may not be substituted for required technical courses or electives. Equivalent technical electives offered by a designated minor as substitutions for required courses in a major must be approved by the Head of the student's major department.

Although a student generally can complete a designated minor without increasing the number of required units for graduation, early planning in electing a designated minor is important. A student also may find that some minors are more compatible than others with his/her major because of different relations between various major and minor requirements. The requirements for these CIT designated minors are listed below.

Automation and Control Engineering Designated Minor

Bruce Krogh, Director Office: Porter Hall B22

The objective of the Designated Minor in Automation and Control Engineering is to expose CIT students to the breadth of knowledge required by the modern practice of control and automation. With this objective in mind, the requirements include not only two courses in control system analysis and design, but also courses on real-time computation, software engineering, hardware implementation, and applications. The minor is expected to attract primarily students from Chemical Engineering, Electrical and Computer Engineering, and Mechanical Engineering. The main interdisciplinary component of the minor is between engineering and computer science, although many opportunities exist for creating a program across several CIT departments.

Faculty Advisors

Electrical & Computer Engineering - Pradeep K. Khosla
 Civil & Environmental Engineering - James Garrett
 Mechanical Engineering - William Messner
 Chemical Engineering - Erik Ydstie
 Course Requirements for Automation and Control

Engineering Minor

The minor requires a minimum of six courses as described below:

Note: The course lists below are not necessarily current or complete. Appropriate courses not listed below may be counted toward the requirements for the minor upon approval by one of the departmental faculty advisors. Students interested in the Automation and Control Engineering Designated Minor are encouraged to look for applicable courses each semester in CIT, CS, and Robotics.

One basic control course:

06-362	Chemical Engineering Process Control
18-470	Fundamentals of Control
24-451	Feedback Control Systems

One course on control system analysis and design:

06-708	Advanced Process Dynamics and Control
18-771	Linear Systems

One course on computing and software:

15-211	Fundamental Data Structures & Algorithms
15-212	Principles of Programming
12-741	Advanced Programming Concepts in CAE
18-549	Embedded Systems Design
18-649	Embedded Systems

One course on hardware implementation:

06-311	Unit Operations Laboratory
18-474	Embedded Control Systems
18-578	Mechatronic Design

One course on applications:

06-606	Computational Methods for Large Scale Process Design and Analysis
12-615	Traffic Flow Theory and Operations
16-311	Introduction to Robotics
16-743	Robot Control
16-761	Introduction to Mobile Robots
24-356	Engineering Vibrations
24-351	Engineering Dynamics
xx-xxx	12 independent project units

One elective course:

xx-xxx	Any course in the list above excluding the basic control course category
12-748	Design of CAE Systems
15-381	Artificial Intelligence: Representation and Problem Solving
15-385	Computer Vision
15-413	Software Engineering
15-498	Introduction to Real-Time Software
18-348	Embedded Systems Engineering
18-349	Embedded Realtime Systems
18-491	Digital Signal Processing I
18-771	Linear Systems
18-777	Complex Large-Scale Dynamic Systems
24-341	Manufacturing Sciences

Biomedical Engineering Designated Minor

Todd Przybycien, Director
 Office: Doherty Hall A-220

Biomedical Engineering (BME) at Carnegie Mellon is designed to train engineering students to apply the techniques of mathematics and science to the solution of problems in medicine and biology. Emphasis is placed on describing biological organisms as engineering systems and on applying engineering technology to clinical and laboratory situations. Students graduate with an accredited engineering degree in a traditional engineering major with a minor in biomedical engineering.

What Can a Student Do After Completing the Bachelor's Degree?

Upon completing the Biomedical Engineering Minor, the student may elect to continue graduate studies in Bioengineering at either the Masters or Ph.D. levels, or continue in medical school for the

MD degree. Many of the courses in the BME minor will assist in preparing you for medical school. Students who remain in the field of biomedical engineering are involved with developing and improving medical instruments and devices, automating medical procedures using computers, characterizing the operation of physiological systems, designing artificial organs and altering microbes and mammalian cells so that useful drugs and chemicals can be produced.

The graduate may secure employment in areas of bioinstrumentation, biocompatibility, optics, pharmacology, or the environment.

Faculty Advisors

The Biomedical Engineering Program provides a focus for faculty from diverse engineering backgrounds. There is also extensive collaboration with investigators in the local health care community. Clinical collaborations are seen as vehicles to keep research responsive to clinical needs, enhance the exposure of our students to a variety of clinical environments, and assist the clinical community in solving engineering problems.

One faculty member will be assigned the advisor to each engineering department. Hilda Diamond in Doherty Hall 2100 will also help with the bookkeeping aspects of advising and attention to details (student course requirements, scheduling of BME courses, working with departments to avoid conflict). Coordination with advising in the other major of the student is essential. Students will need to have traditional engineering advisor to approve final schedules. Following are advisors in departments:

Chemical Engineering: Dr. Todd Przybycien, Dr. Michael Domach, Dr. Lynn Walker
Civil & Environmental Engineering: Dr. Jean VanBriesen
Electrical & Computer Engineering: Dr. Richard Stern, Dr. Chuck Neuman
Materials Science & Engineering: Dr. Lisa Porter; Dr. Henry Piehler
Mechanical Engineering: Dr. Cristina Amon, Dr. Jon Cagan

A summer opportunities program is available to students pursuing the minor at the completion of their sophomore year.

Course Requirements for Biomedical Engineering Designated Minor

General Requirements (five courses, 48-51 units)

- Introduction to BME (42-101) 12 units
- Modern Biology (03-121) or Biochemistry (03-231 or 232) 9 units
- BME Elective or Domain 9-12 units
- BME Elective or Domain 9-12 units
- BME Elective or Domain 9-12 units

BME Domain Courses

03-121	Modern Biology
03-240	Cell Biology
03-310	Introduction to Computational Biology
03-311	Computational Molecular Biology
03-330	Genetics
03-343	Experimental Generics and Molecular Biology
03-344	Experimental Biochemistry
03-345	Experimental Cell and Developmental Biology
03-350	Developmental Biology
03-438	Physical Biochemistry
03-439	Introduction to Biophysics
03-441	Molecular Biology of Prokaryotes
03-442	Molecular Biology of Eukaryotes
03-510	Computational Biology
03-533	NMR in Biomedical Sciences
03-534	Bio Imaging Fluorescence Spectroscopy
09-245	Physical Chemistry II
15-211	Fundamental Structures of Computer Science I
42-301	Physiology
42-377	Rehabilitation Engineering
42-501	Special Topics: Biomaterials I & II
42-560	Research Project (at CMU or UPMC)
42-604	Biological Transport
42-621/06-621	Biotechnology & Environmental Processes
42-622/06-622	Bio Process Design
42-644	Medical Devices
42-651/12-651	Air Quality Engineering
42-652	Introduction to Biomechanics
42-723/12-723	Biological Processes in Environmental Systems

BME Electives

06-607	Phys Chem of Colloids and Surfaces
06-609/09-509	Physical Chemistry of Macromole 06-313
06-313	Exp Colloid Science
06-314	Exp Polymer Science

06-426	Experimental Colloid Surface Science
06-466	Experimental Polymer Science
18-3XX*	
19-607	Special Topics in Biotechnology
24-354	General Robotics
24-779	Human Systems and Control
27-432	Electrical, Magnetic, and Optical Properties of Materials
27-441	Deformation and Fracture of Materials
36-247	Statistics for Lab Sciences
39-319	Law and the Engineer
88-270	Networking: Organizations, Knowledge, and Technology
88-302	Behavioral Decision Making
88-340	Economics of Entrepreneurship in High Technology Industries
90-830	Financial Management of Health System
90-831	Health Management Systems
90-836	Legal Issues in Health Systems Management
90-837	Health Project Planning & Management
90-650	Introduction to Health Care Management
90-853	Health Care Information Systems
90-861	Health Policy

*Since most Electrical and Computer Engineering courses are electives and circuits and signals integral to many medical technologies, a student could use just about any 18-XYZ course where X is greater than 1 and a student can satisfy prerequisites or obtain permission from the instructor.

Students are encouraged to select an interdisciplinary capstone course or independent research project for one of the BME electives.

Like the requirements for the BME double major, the requirements for the BME minor satisfy various categories of electives in the curriculum and should not increase the total number of units/courses required for the primary CIT degree.

Colloids, Polymers and Surfaces

Annette Jacobson, Director Office: Doherty Hall 3102B

The sequence of courses in the Colloids, Polymers and Surfaces (CPS) designated minor provides an opportunity to explore the science and engineering of fine particles and macromolecules as they relate to complex fluids and interfacially engineered materials. These topics are very relevant to technology and product development in industries that manufacture pharmaceuticals, coatings and paints, pulp and paper, biomaterials, surfactants and cleaning products, cosmetics and personal care products, food, textiles and fibers, nanoparticles, polymer/plastics, composite materials.

Course Requirements for Colloids, Polymers and Surfaces Designated Minor

One course from the following list:

06-221	Thermodynamics
24-221	Thermodynamics I
27-215	Thermodynamics of Materials
33-341	Thermal Physics I
09-345	Physical Chemistry II (Thermo)

The following four courses are required:

06-609/09-509	Physical Chemistry of Macromolecules
06-607	Physical Chemistry of Colloids and Surfaces
06-426	Experimental Colloid and Surface Science
06-466	Experimental Polymer Science

Data Storage Systems Technology Designated Minor

William C. Messner, Director Office: Scaife Hall 312

To complete the minor in Data Storage Systems Technology a student must take at least five courses from the list below. Two of the courses must come from the Required Courses list. Introduction to Data Storage Systems (18-416), and Introduction to Solid State Physics (33-448). The student must also take at least three of the elective courses. The various fields related to data storage technology are grouped in to five designated concentration areas — Materials and Chemistry; Physics of Data Storage; Dynamics, Control, and Signal Processing; Computer Systems; and Circuit Design. At least two of the elective courses must be in one of the concentration areas. The required introduction courses provide students with the overview needed for them to develop their interests in a manner consistent with the important aspects of the topic. Completing the courses from a concentration will guarantee that a student will have developed sufficient skill and knowledge to be useful for either employment in industry or for further study at the graduate level.

Course Requirements for Data Storage Systems Technology Minor

Required Courses (Two Undergraduate Courses):

18-416	Data Storage Systems
33-448	Introduction to Solid State Physics

Elective Courses

Materials and Chemistry Concentration

06-607	Physical Chemistry of Colloids and Surfaces
06-609	Physical Chemistry of Macromolecules
06-619	Semiconductor Processing
06-709	Polymeric Materials
06-714	Surfaces and Adsorption
09-348	Inorganic Chemistry
09-511	Solid State Materials Chemistry
27-432	Electronic and Thermal Properties of Metals, Semiconductors and Related Devices
27-542	Structure and Properties of Thin Films

Physics of Data Storage Concentration

33-225	Quantum Physics and the Structure of Matter
33-353	Intermediate Optics
33-448	Introduction to Solid State Physics

A graduate course in quantum physics, magnetism, or optics

Dynamics, Control and Signal Processing Concentration

24-451	Feedback Control Systems
24-356	Engineering Vibrations
18-396	Signals and Systems
18-474	Embedded Control Systems

A graduate course in controls, dynamics, or signal processing

Computer Systems Concentration

15-412	Operating Systems
18-348	Embedded Systems Engineering
18-349	Embedded Real Time Systems
18-549	Embedded Systems Design
18-649	Distributed Embedded Systems

A graduate course in computer systems

Circuit Design Concentration

18-525	Integrated Circuit Design Project
18-545	Advanced Digital Design Project

A graduate course in circuit design

Other Non-Concentration Courses

An independent study project approved by the coordinator of the minor.

Other regular course approved by the coordinator of the minor.

Electronic Materials Designated Minor

David W. Greve, Director Office: Hamerschlag Hall B204
Lisa A. Porter, Co-Director Office: Roberts Engineering Hall 145

Many of the technological changes in recent decades—notably the rise of digital data processing—has been made possible by continuing advances in the performance of electronic devices. These advances include continuous improvement in microprocessor performance, optical communication bandwidth, and magnetic disk storage capacity. Other new areas of innovation include the development of micromechanical systems and the development of flat panel display technology. These advances depend on interactions between engineers from many different disciplines. In particular, there is a strong interaction between device design and materials engineering and processing.

The Electronic Materials Minor is intended to provide students with a firm basis for the application of electronic materials in advanced systems. This minor is well suited for students who intend to pursue careers in the electronics industry (included, but not limited to, semiconductor integrated circuit design and manufacturing, and magnetic storage engineering). The minor also provides an excellent preparation for students interested in pursuing graduate work in MSE, ECE, or Applied Physics.

This minor is primarily intended to offer ECE and MSE students an understanding of the important features that must be built into a material during processing so that it will function as required in an electronic or magnetic device. Other students interested in pursuing this minor should consult their advisors to determine whether it will be practical in their own curriculum. Such students are expected to take both 18-100 and 27-201 as introductory courses.

Students in the Electronic Materials program are urged to consider registering for an undergraduate project in addition to the requirements below, especially if they intend to apply to graduate school. The co-directors will make every effort to arrange a suitable project for interested students.

Faculty Advisors

The designated minor will be administered by the co-directors listed above. Current faculty advisors are:

Chemical Engineering - Paul Sides Civil and Environmental Engineering - Jacobo Bielak Michael Reed and T. E. Schlesinger Engineering and Public Policy - M. Granger Morgan Materials Science and Engineering - Marek Skowronski

Course Requirements for Electronic Materials Minor

The minor requires an introductory course together with a minimum of 48 additional units as specified below.

Required Introductory Courses:

18-100	Introduction to Electrical & Computer Engineering (MSE students)
27-201	Perfect Crystals including lab (ECE students)

Elective Courses:

48 additional units, with 24 units from Group A and 24 units from Group B. Some courses are a required part of one of the curricula and consequently cannot be counted again for the minor program.

We have determined that "courses which are a required part of a curriculum" are those which are specifically named in the curriculum requirements. Consequently technical electives and breadth and depth electives may be double-counted.

Group A

27-202	Defects in Materials (ECE students only)
06-619	Semiconductor Processing Technology
27-542	Thin Films
27-217	Phase Relations (ECE students only)
27-533	Principles of Growth and Processing of Semiconductors
27-432	Electronic, Magnetic, and Optical Properties (only if not required in your curriculum)
27-551	Properties of Ceramics and Glasses
27-216	Transport in Materials (ECE students only)
33-225	Quantum Physics and Structure of Matter (ECE students only)

Group B

18-310	Fundamentals of Semiconductor Devices
18-416	Data Storage Systems
18-715	Physics of Applied Magnetism
18-716	Advanced Applied Magnetism

18-8XX An appropriate 800-level course
(for example, 18-813, 18-815, 18-819).
Other appropriate courses may be substituted with the approval of the coordinators in the event that limited course offerings make it impossible to satisfy the requirements as described above.

Engineering Design Designated Minor

Susan Finger, Director Office: Porter Hall 123B

Design is a pervasive activity in all engineering disciplines. Insuring quality, timeliness, manufacturability and marketability of engineering designs is a crucial concern in product development. The CIT designated minor in Engineering Design is intended to provide a firm methodological basis for engineering design that will be broadly applicable in numerous specialty domains. The minor is intended primarily for engineering undergraduates who want a broader and more formal foundation in design. The requirements for the minor consist of two interdisciplinary design courses which emphasize design methodology, team work, and real-world problem solving, and three elective courses, at least one should involve CAD and at least one should be outside the student's major.

Faculty Advisors

The designated minor in Engineering Design is administered by the Director of the Institute for Complex Engineered Systems. Students undertaking the designated minor can consult with the program advisor in their major department.

Current faculty advisors are:

Chemical Engineering - Larry Biegler and Ignacio Grossman
Civil and Environmental Engineering - Susan Finger and Jim Garrett
Electrical and Computer Engineering - Daniel P. Siewiorek
Engineering and Public Policy - Indira Nair
Mechanical Engineering - Kenji Shimada
Materials Science and Engineering - Robert Heard
Course Requirements for Engineering Design Minor

Required Courses:

Select at least two of the following courses.

39-245 Rapid Prototype Design
39-405 Engineering Design: Creation of Products and Processes
39-600 Integrated Product Development
39-605/606/647 Engineering Design Projects Courses
39-648 Rapid Prototyping of Computer Systems

Elective Courses:

Additional elective courses are required, including at least 9 units outside the student's major department and at least one course involving applications of computer-aided design methods. A total of 45 units is required for the minor, including required and elective courses. Courses can be chosen from the list below, the previous list, or by permission of the Minor Advisors.

Undergraduate Elective Courses:

06-302 Process Engineering and Synthesis
06-606 Computational Methods for Large Scale Process Design & Analysis
12-401 Civil and Environmental Engineering Design
12-605 Design and Construction
12-631 Structural Design
12-675 Computer-Aided Tools for Civil & Environmental Engineers
18-321 Analysis and Design of Analog Circuits
18-322 Analysis and Design of Digital Circuits
18-347 Introduction to Computer Architecture
18-349 Introduction to Embedded Systems
18-360 Introduction to Computer-Aided Digital Design
18-474 Computer Control Systems Design Laboratory
18-517 Data Storage Systems Design Project
18-523 Analog Integrated Circuit Design
18-525 Integrated Circuit Design Project
18-545 Advanced Digital Design Project
18-547 Computer System Design
18-551 Digital Communications and Signal Processing Systems Design
18-575 Control System Design
24-441 Engineering Design
24-442 Engineering Design - EPP
24-443 Design for Manufacture
27-357 Introduction to Materials Selection
27-421 Processing Design
39-647 Independent Study in Engineering Design
42-580 Medical Instrumentation Design

Graduate Elective Courses

06-720 Advanced Process Systems Engineering
12-747 CAE Software Project
12-740 CAE Tools
12-784 Artificial Intelligence for Design
18-725 Digital Integrated Circuit Design
18-748 Dependable System Design
18-760 VLSI CAD: Logic to Layout
18-761 VLSI CAD: Layout to Manufacture
18-763 Physical CAD for VLSI
18-765 Digital System Testing and Testable Design
18-778 Mechatronic Design
18-814 Microelectromechanical Systems
24-788 Mechatronic Design
16-788 Mechatronic Design
24-781 Design Procedures
24-784 Computational Design Tools
27-721 Processing Design

Environmental Engineering and Sustainability Designated Minor

Jeanne VanBriesen, Director
Office: Porter Hall 119

Concern for the environment now influences a wide range of public, private and engineering decisions. Environmental Engineering is widely recognized as a discipline at the graduate and professional level, and undergraduate training in environmental issues and processes can provide the preparation necessary to pursue this career path, or serve as a useful complement to a career in any of the traditional areas of engineering. Sustainability issues are not considered critical across engineering disciplines. Effective preparation requires broad knowledge and skills in the areas of environmental science, environmental engineering and environmental policy.

Faculty Advisors

The Environmental Engineering program is a focus for faculty members from diverse engineering backgrounds. The faculty are actively engaged in teaching and conducting research in this field. Current faculty advisors are:

Biomedical Engineering - Robert Tilton
Chemical Engineering - Neil M. Donahue
Civil and Environmental Engineering - Jeanne VanBriesen
Electrical and Computer Engineering - Marija Ilic
Engineering and Public Policy - Mark Kieler and Edward Rubin
Mechanical Engineering - Allen Robinson
Materials Science and Engineering - Paul Salvador and Robert Heard

Course Requirements for Environmental Engineering and Sustainability Minor

The requirements include two core courses, three technical electives, and two policy electives.

A1. Core Courses in Sustainability (12 units)

Select one set of **two** mini courses from:

19-622 (co-listed as 12-712) Sustainability
19-623 (co-listed as 12-713) Industrial Ecology
OR
19-614 (co-listed as 12-714) Life Cycle Assessment
19-616 (co-listed as 12-715) Case Studies in Sustainability

A2. Core Courses in Environmental Engineering (9 units)

Select **one** NOT in your home major department from:

12-351 Fundamentals of Environmental Engineering
24-424 Energy and the Environment (co-listed as 19-424)
12-651 Air Quality Engineering
24-425 Combustion and Air Pollution Control
12-702 Fundamentals of Water Quality Engineering
06-620 Global Atmospheric Chemistry: Fundamentals and Data Analysis Methods

B. Technical Electives in Environmental Engineering and Sustainability (27 units)

Select **three** from the following list

03-121 Modern Biology
09-106 Modern Chemistry II
09-510 Introduction to Green Chemistry

06-620	Global Atmospheric Chemistry
12-351	Fundamentals of Environmental Engineering
12-651	Air Quality Engineering
12-702	Fundamentals of Water Quality Engineering (new course proposed by CEE for Fall 2008)
12-657	Water Resources Engineering
12-658	Hydraulic Structures Design
24-424	Energy and the Environment
24-425	Combustion and Air Pollution Control
19-622	Sustainability (also listed as 12-712) *
19-623	Industrial Ecology (also listed as 12-713) *
19-614	Life Cycle Assessment (also listed 12-714) *
19-616	Case Studies in Sustainability (also listed as 12-715) *
19-650	Climate and Energy: Science, Economics, and Public Policy
27-322	Processing of Metals **
27-323	Powder Processing of Metals **
27-421	Processing Design *
27-367	Selection and Performance of Materials *
27-594	Electrochemical Processes in Materials
42-621	Biotechnology and Environmental Processes (also listed as 06-621)
48-315	Environment I: Climate and Energy
48-415	Advanced Building
48-596	LEED Building and Green Design Concepts
48-569	GIS/CAFM (also listed as 90-784)
48-572	Zero Energy Housing

- * 6 units; must be combined with 3 additional units
 ** Students may take either 27-322, Processing of Metals, or 27-323, Powder Processing of Metals, but not both, as technical electives in this category.

C. Policy Electives (18 units)

Select **two** from the following list of humanities/social science-oriented courses:

12-608	Implications of Engineering in Global Society
19-448	Science, Technology and Ethics
48-567	Sustainable Design and Development
48-576	Mapping Urbanism
66-210	Science, Technology and the Environment
73-248	Environmental Economics
73-357	Regulation: Theory and Policy
73-358	Economics of the Environment and Natural Resources
73-359	Benefit-Cost Analysis
76-319	Environmental Rhetoric
79-111	Cultural Perspectives on the Environment
79-244	Pittsburgh and the Transformation of Modern Urban America
79-326	The Role of the Environment in the Collapse of Ancient Societies
79-336	Epidemic Disease and Public Health
79-343	Environmental Policy and Development in the Tropical World
79-345	American Environmental History: Critical Issues
79-346	International Environmental Law and Policy (also listed as 88-352)
79-365	Climate Change, Energy Policy and Environmental Protection
79-398	Environmental History and Politics Since Silent Spring (also listed as 88-346)
79-471	American Built Environment Since 1860
79-475	Perspectives on the City and the Environment (also 90-762)
79-211	Disaster! Fires, Plagues, Hurricanes and Floods in American History
79-212	Disastrous Encounters: Technology and the Environment in Global Historical Context
80-242	Conflict and Dispute Resolution
80-244	Environmental Management and Ethics
88-220	Policy Analysis I
88-221	Policy Analysis II
88-223	Decision Analysis and Decision Support Systems
80-340	Environmental Ethics and Decision Processes
99-522	Corporations and Environmental Responsibility
90-747	Cost-Benefit Analysis
90-758	Ethics and Public Policy in a Global Society
90-765	Cities, Technology and the Environment
90-789	Sustainable Community Development
90-798	Environmental Policy and Regulation
90-851	Environmental Policy
90-859	Environmental Conflict Resolution

NOTES:

1. The 48-xxx courses may not be acceptable as technical electives by some CIT engineering departments (At most one of these courses can be used as a Type B course and one as a Type C

2. Course 12-351 Fundamentals of Environmental Engineering can be counted toward completion of the environmental engineering and sustainability course requirements for non-CEE students only.
3. Courses cannot be double-counted for lists A and B.
4. Courses used to fulfill the basic science requirement for CIT cannot be double-counted for list B requirements. Courses required within a student's CIT major can be double-counted for list B requirements.
5. Students may take up to two list B courses in their home department. One list B course must be from outside their home department. EPP double-majors should NOT consider EPP their home department.
6. Other H&SS courses with similar or related content may be substituted for Type C courses with permission of the student's departmental advisor and the Director.
7. A group of three environmental policy courses MAY be counted as fulfilling the H&SS depth requirement required of all CIT students.
8. A list of relevant courses for Type B and C in each semester is provided at the Environmental Engineering and Sustainability Minor website: <http://www.ce.cmu.edu/~dzombak/envminor.html>

International Engineering Studies Designated Minor

Kurt Larsen, Director
 Office: Scaife Hall 110

Many engineers work on international projects or for multinational companies. Carnegie Mellon is an international community, with a significant fraction of international students and many events featuring foreign speakers and cultural experiences. This minor is intended for engineering students interested in broadening their background in international experiences and global awareness and engagement.

Requirements for the minor include:

International Management (1 course)

Complete one course in international management or business such as:

70-342	Managing Across Cultures
70-365	International Trade and International Law
70-381	Marketing I
70-430	International Management

or approved equivalent.

Regional Specialization (1 course)

Complete one course in non-US History, international politics, or literature in a single region of the world. (See page 225 in the undergraduate catalog for a list of courses suggested for Africa, Asia, Europe, Latin America/Caribbean, Middle East and Russia).

Ethics (1 course)

Any ethics course that provides some exposure to international ethics issues such as:

70-332	Business, Society and Ethics
80-243	Business Ethics
80-244	Environment Management and Ethics

or approved equivalent.

Modern Languages

Demonstration of basic competency in a foreign language via one of the three options listed below:

1. Complete one (1) Modern Languages course at the 200 level, with a minimum grade of C, or
2. Achieve a score of 4 or higher in one foreign language Advanced Placement examination, or
3. Demonstrate equivalent proficiency to the satisfaction of the Department of Modern Languages

Study/Work Abroad

Study or engineering internship work abroad for a semester or a summer or participate in an approved short-term global experience program.

Manufacturing Engineering Designated Minor

Bruce H. Krogh, Director Office: Porter Hall B22

The Designated Minor in Manufacturing Engineering provides the student with a background in the basic engineering issues that arise in all manufacturing enterprises, from product design through production processes, to issues in marketing and management.

Faculty Advisors

A faculty member from each department will serve as the faculty advisor for the students who are pursuing the minor degree in their respective departments. Current faculty advisors are:

Chemical Engineering - Arthur Westerberg
 Civil and Environmental Engineering - Susan Finger
 Electrical and Computer Engineering - Bruce H. Krogh
 Engineering and Public Policy - Mark Kieler
 Materials Science and Engineering - Anthony D. Rollett
 Mechanical Engineering - Kenji Shimada

Course Requirements for Manufacturing Engineering Minor

Note: The course lists below are not necessarily current or complete. Appropriate courses not listed below may be counted toward the requirements for the minor upon approval by one of the departmental faculty advisors. Students interested in the Manufacturing Engineering Designated Minor are encouraged to look for applicable courses each semester in CIT, CS, and Robotics.

Two Core Courses:

24-341 Manufacturing Sciences
 27-357 Introduction to Materials Selection (non MSE Majors)
 OR
 27-401 & 402 MSE Capstone Course, I & II (MSE Majors)

Note: Instructor's permission to waive the prerequisites for the core courses will be considered for students pursuing the Manufacturing Engineering Designated Minor.

Technical Electives:

A total of three courses must be selected from at least two of the following categories. Courses taken to fulfill requirements for the student's major, other than technical elective requirements, cannot be used to fulfill this requirement.

Real-Time Systems and Robotics

16-721 Advanced Robot Perception
 16-741 Mechanics of Manipulation
 16-743 Robot Control
 18-348 Embedded Systems Engineering
 18-349 Embedded Real-time Systems
 18-474 Embedded Control Systems
 18-549 Embedded Systems Design
 18-649 Distributed Embedded Systems
 18-778 Mechatronic Design

Design, Materials and Processes

06-362 Chemical Engineering Process Control
 24-443 Design for Manufacture
 27-322 Processing of Metals
 27-323 Processing of Ceramic Materials
 27-421 Design in Process Metallurgy
 27-422 Deformation Processing
 27-592 Solidification Processing
 27-322 Processing Methods
 27-421 Processing Design
 27-442 Deformation Processing
 27-533 Principles of Growth and Processing of Semiconductors
 36-600 Design, Manufacturing and Marketing of New Products
 39-245 Special Topics: Rapid Prototype Design
 39-405 Engineering and Design: the Creation of Products and Processes

Production Management and Control

12-411 Engineering Economics
 12-611 Project Management for Construction
 36-220 Engineering Statistics and Quality Control
 70-430 International Management
 70-371 Production and Operations Management
 70-471 Production II

Language:

Because of the international nature of manufacturing enterprises, students are strongly encouraged to complete one of the following:

82-221/222 Intermediate German: Culture and Society
 82-271/272 Intermediate Japanese

Materials Science and Engineering Designated Minor

Michael E. McHenry, Director
 Office: Roberts Engineering Hall 243

The Designated Minor in Materials Science and Engineering provides the CIT student with a background in the field of Materials Science and Engineering. This minor is open to all CIT students, with the exception of MSE majors. All required and elective courses are taught within the MSE Department.

Course Requirements: The minor requires a minimum of 45 units, with two semester long required courses (the first being a sequence of two minis).

Prerequisites: Students wishing to take the MSE minor must have prerequisite thermodynamics and transport courses. The prerequisite MSE courses may be substituted for by a thermodynamics and transport course in another engineering discipline.

Core Courses (21 units)

Course One (consisting of two half semester minis): 27-201, Perfect Crystals (6 units), 27-202, Defects in Materials (6 units). The laboratories with these courses are not required as core but will be counted as elective units if desired.

Course Two: 27-217, Phase Relations and Phase Diagrams (9 units), again the laboratory with this course will not be required as core but will be counted as elective units if desired.

Elective Courses (24 units minimum)

The student must select a minimum of 24 units from the following list:

27-100 Introduction to Materials Science
 27-201(a) The Structure of Materials (3 units)
 27-202(a) Defects in Materials Laboratory (3 units)
 27-217(a) Phase Relations and Phase Diagrams Laboratory (3 units)
 27-301 Microstructure and Properties
 27-302 Microstructure and Properties II
 27-322 Processing of Metals
 27-323 Processing of Ceramic Materials
 27-357 Introduction to Materials Selection
 27-510 Bio-Materials I
 27-511 Bio-Materials II
 27-582 Phase Transformations in Solids
 27-421 Processing Design
 27-432 Electrical, Magnetic and Optical Properties of Materials
 27-591 Mechanical Behavior of Materials
 27-560 Physical Chemistry of Metallurgical Reactions
 27-454 Supervised Reading
 27-530 Physical Metallurgy with Applications
 27-533 Principles of Growth and Processing of Semiconductors
 27-542 Processing and Properties of Thin Films
 27-551 Properties of Ceramics and Glasses
 27-566 Special Topics
 27-592 Solidification Processing
 42-644 Medical Devices

Mechanical Behavior of Materials

Designated Minor

Warren M. Garrison, Jr., Director
Office: Wean Hall 3303

An understanding of mechanical behavior is important to both the development of new materials and the selection of appropriate materials for many applications. The mechanical behavior of materials is best investigated and understood by integrating solid mechanics with the microstructural basis of flow and fracture. The purpose of this minor is to allow a formal basis for students to pursue an integrated approach to the mechanical behavior of materials.

Although this minor is open to all CIT students, only students in the departments of Civil Engineering, Materials Science and Engineering, and Mechanical Engineering can take advantage of the double counting permitted for some courses in their department majors. Students in other departments may have difficulty in fulfilling the requirements in four years.

Faculty Advisors

Chemical Engineering - Paul Sides
Electrical and Computer Engineering - David W. Greve
Mechanical Engineering - Paul S. Steif
Materials Science and Engineering - Warren M. Garrison, Jr.

Course Requirements

The minor requires six courses: three core courses, two solid mechanics courses, and one materials science course. In satisfying these course requirements, each student must take three out-of-department courses. Each student is required to complete three core courses:

Core Courses:

27-201 Perfect Crystals
27-591(or 27-791) Mechanical Behavior or Materials
12-235(or 24-261) Statics

Group A: Materials Science Courses

Each student must take one course from this list of Materials Science courses:

27-202 Defects in Materials¹
27-357 Selection and Performance of Materials²
27-551 Properties of Ceramics or Glasses
42-511 Biomaterials II
27-530 Advanced Physical Metallurgy

Group B: Solid Mechanics Courses

Each student must take two of the following Solid Mechanics courses:

12-331 Solid Mechanics
or
24-262 Stress Analysis
12-635 Structural Analysis
or
24-351 Dynamics
24-751 Introduction to Solid Mechanics

¹ 27-202 cannot be used by MSE students to satisfy the requirements of the minor.

² 27-357 cannot be used by MSE students to satisfy the requirements of the minor.

Students should check with the director of the program or their faculty advisor for an up-to-date list of relevant courses that will count towards this minor. For more information, please consult the Undergraduate Course Catalog and the current Schedule of Classes.

Department of Biomedical Engineering

Dr. Yu-Li Wang, Head
www.bme.cmu.edu

Biomedical engineers apply engineering principles to advance our understanding of living systems and to improve human health. They accomplish this by integrating fundamental engineering science knowledge with knowledge of biology, physiology and clinical practice. Biomedical engineers are employed in the pharmaceutical, biopharmaceutical, biotechnical and medical device industrial sectors as well as in clinical healthcare settings. A significant number of graduates also choose to pursue graduate studies or medical school. Our approach to biomedical engineering education reflects our belief that successful biomedical engineers in these sectors and settings will be deeply trained in both engineering and the life sciences. To underscore this, we use an additional major B.S. degree format for our undergraduate education program. Carnegie Institute of Technology (CIT) undergraduates will elect any one of these following majors with Biomedical Engineering: Chemical Engineering, Civil & Environmental Engineering, Electrical & Computer Engineering, Materials Science & Engineering, or Mechanical Engineering. Each of the additional major degree programs is designed to be completed in four, very full and rich, years.

Our curriculum is structured to provide both breadth and depth within biomedical engineering. Graduates will have a firm understanding of biology and physiology; the ability to apply advanced mathematics, science and engineering to solve problems at the interface between engineering and the life sciences; and the ability to make measurements on and interpret data from living systems, addressing the problems associated with the interaction between living and non-living materials and systems.

The BME curriculum is comprised of three parts: the BME core, the BME track elective system and the BME capstone design course. All biomedical engineering additional majors will share a common exposure to the many facets of biomedical engineering in the BME Intro, Professional Issues and Laboratory courses and will build a common life sciences background in the Modern Biology and Physiology courses that comprise the BME core requirements.

Following the core is our track system. Each student will select a track to build depth within biomedical engineering in the bioimaging, biomaterials and tissue engineering, biomechanics, or cellular and molecular biotechnology areas.

Bioimaging is the study of bio/medical phenomena based on the information provided in digital images. It draws upon advances in signal processing, optics, probe chemistry, molecular biology, and machine learning to provide answers to biological and medical questions from the growing numbers of biological and medical images acquired in digital form. This track aligns most naturally with BME/ECE double majors. A bioimaging specialist will have a broad background and can expect to find work in biomedical industrial labs, pursue further education by going to either graduate or medical school, or be employed by one of the numerous biomedical tech companies developing new instrumentation and/or algorithms for digital imaging.

The Biomaterials and Tissue Engineering track addresses fundamental issues at the interface of materials science, biology and engineering. The course work includes the design and development of materials for biological applications. Students will understand how materials, cells, tissues and organ systems interact and direct rational, practical therapeutic solutions for clinical issues. Characterization techniques for measuring the outcome of biomaterials and biological interactions will be included in the track. BME/ChE and BME/MSE are well suited for additional major matches. Job opportunities for the students trained in materials and tissue engineering include work in biotechnology industries or further studies in graduate or medical school. Significant opportunities are expected for engineers trained in the development and production of biological materials, medical devices, and combination drug-cell-material devices.

Biomechanics refers to the application of principles of solid, fluid, and continuum mechanics to the study of the structure, function, and behavior of biological and medical systems under the influence of mechanical forces. Biomechanics draws on advances in biology, continuum mechanics, experimentation, imaging, applied mathematics, and scientific computing. Biomechanics models

provide quantitative descriptions of molecule, cell, tissue, organ, and whole organism behavior under mechanical stimuli, and are employed to characterize human health, disease, and injury. Biomechanics models are also used in the design of rehabilitative devices and strategies. BME/CEE and BME/ME additional majors are strong matches with this track. A broad background in biomechanics enables students to work in the medical device industry, to work as a rehabilitation engineer, the ability to conduct fundamental biomechanics modeling and experimental research, or to pursue medical or graduate school.

The Cellular and Molecular Biotechnology track emphasizes fundamentals and applications of biochemistry, biophysics, and cell biology. It is ideally suited to the BME/ChE additional major, which provides a strong core of chemistry and molecular processing principles, and is also appropriate for BME/CEE and BME/ME additional majors who have interests in molecular and cellular level detail. The track can also suit molecularly-oriented BME/ECE additional majors with interests in biosensing. This track prepares students for careers or advanced education involving bio/pharmaceutical manufacture, pharmacology, medical diagnostics, biosensors, drug delivery devices, and biological aspects of environmental engineering. Students pursuing the Cellular and Molecular Biotechnology track will acquire a deeper understanding of the molecular and cellular bases for the life processes. One of the unique characteristics of this track is an emphasis on processes and structures occurring on the nanometer to micrometer size scale range. Students following this track will acquire insights and quantitative modeling skills needed to develop biotechnologies based on live cell cultures, as well as technologies that exploit the unique properties of biomolecules in non-biological settings.

Each track requires a track gateway course which provides a common foundation for all who choose that track. The gateway course is typically followed by three electives chosen from a longer list of track electives. A dynamic listing of available track electives is maintained on the departmental web site. The areas of biomedical engineering represented by these tracks correspond to those areas in which Carnegie Mellon has coordinated research strengths. As a result, the courses are taught by experts who have direct, current experience and active research in that specialty. While there are natural alignments between the Biomedical Engineering track and the student's engineering major, there are no restrictions; all biomedical engineering tracks are open to all engineering majors. A general biomedical engineering track is also available for those students intending on pursuing graduate studies or medical school.

The additional major degree program culminates in the BME Design courses – a 3 unit mini-course, "Foundations of BME Design," taught in the fall semester of the senior year, followed by a 9 unit course, "BME Design" taught in the spring semester of the senior year. These courses pull together biomedical engineering students from all engineering backgrounds into design teams. The design teams tackle industry- and clinic-sponsored projects to develop products and product concepts relevant to human healthcare and the life sciences. The projects typically result in the production of a prototype and have resulted in patent applications and the pursuit of licensing opportunities.

Several questions naturally arise. Why the additional major? Why not a stand-alone BME degree? Where's the medical school? Again, we aim to graduate students who are educated in the use of traditional, fundamental engineering tools and analytical techniques as well as in the life sciences and clinical applications of technology. Due to its polydisciplinary nature, the field of biomedical engineering requires broad exposure to a wide variety of engineering principles. We feel this breadth of exposure should be complemented by the in-depth training in engineering fundamentals that the additional major format affords. While Carnegie Mellon does not have a medical school, the western Pennsylvania area is rich in medical research activity. We leverage our efforts with extensive collaboration with researchers and instructors from the University of Pittsburgh Medical Center, the Western Pennsylvania/Allegheny Hospital System, and the Children's Hospital systems. These collaborations reinforce the clinical relevance of our education and research activities. Our

approach to education is very different from that of the biomedical engineering community at large. And as the number of biomedical engineering degree programs continues to grow, we expect this difference, in particular the additional major degree training of our graduates, will confer a distinct and marketable advantage. Our graduates will shape the future of industrial, clinical and academic biomedical engineering and healthcare.

Biomedical Engineering also offers a minor program for those students who desire coordinated training in biomedical engineering but who may not have the time available in their schedules to permit pursuit of the additional major. The minor aims to provide undergraduates from within CIT and outside CIT with significant and meaningful exposure to specific biomedical engineering applications. Participants in the minor program can choose from course offerings within the elective track system to build marketable skills in a particular area of biomedical engineering.

The dynamism of the biomedical engineering field has created an incredibly exciting environment for students, faculty and staff alike at Carnegie Mellon. We invite you to share your educational experience with us.

Course Requirements for the Additional Major Degree

The requirements include five BME core courses, participation in a BME elective track consisting of a coherent program of four courses, and the BME design course. Core courses will be taken by all students to insure that a basic foundation is acquired in the life sciences. The BME Intro and Laboratory courses are designed to provide broad exposure to the elective track areas and to help students choose an elective track in which to participate. The elective track sequences will allow students to explore in more depth an area of biomedical engineering that complements their major; these courses are explicitly focused on technical aspects of biomedical engineering or the underpinning life sciences. The design course is a project course where students with some common background, yet different expertise, work on a substantial problem in biomedical engineering. Courses that fulfill these requirements are listed below; sample curricula for several of the most common additional majors are also provided.

Core Courses (all required)

42-101	Introduction to Biomedical Engineering Fall and Spring (coreq. or prereq.: 03-121)
42-201	Professional Issues in Biomedical Engineering Fall and Spring
42-202	Physiology Fall and Spring (prereq.: 03-121 or permission of instructor)
42-203	Biomedical Engineering Laboratory Fall and Spring (prereqs.: 42-101 and 42-202; students may substitute 03-124 Modern Biology Laboratory to fulfill pre-medical requirements).
03-121	Modern Biology Fall and Spring
42-401	Foundations of BME Design * Fall (prereqs: Senior BME additional-major status)
42-402	BME Design Spring

*42-401 is a mini that is scheduled for the last half of the fall semester; it begins the day of Mid-semester and ends the last day of classes. It is the precursor for 42-402 BME Design scheduled in the spring.

Elective Tracks (participation in one track required)

The track areas are: Bioimaging (BIMG), Biomaterials and Tissue Engineering (BMTE), Biomechanics (BMEC), Cellular and Molecular Biotechnology (CMBT), and General Biomedical Engineering (GBME). Track courses include a "gateway" required track course taken typically during the junior year, in addition to three electives at the junior or senior level, chosen from a set of track electives. A student may replace one track elective with a research project, either 42-200 Sophomore BME Research Project, 42-300 Junior BME Research Project, 42-400 Senior BME Research Project, 39-500 CIT Honors Project, as long as the research project is on a BME topic, supervised by a regular or courtesy BME faculty member, and the project is conducted for 9 or more units of credit, OR take 42-506 Surgery for Engineers. You cannot take a research course AND 42-506 Surgery for Engineers to replace 2 track electives.

Bioimaging (BIMG) Track

BIMG Gateway Course (required)

18-396 Signals and Systems – Spring

BIMG Track Electives (choose 3)

03-534	Biological Imaging and Fluorescent Spectroscopy
18-491	Digital Signal Processing
18-798	Image, Video, and Multimedia
18-799A	Special Topics in Signal Processing: Bioimage Registration
42-334	Introduction to Computational Biology OR 42-334 Computational Biology (OR 42-434)
42-431	Bioimage Informatics – Spring
42-506	Surgery for Engineers ** – Fall/Spring
42-735/16-725	Medical Image Analysis – Spring
42-X00	BME Research **

** Please note that 42-506 (Surgery for Engineers) and 42-X00 (BME Research) cannot both be used as track electives. You may select one for a track elective.

Biomaterials and Tissue Engineering (BMTE) Track

BMTE Gateway and Capstone Course (required)

03-232	Biochemistry – Spring (MSE majors may substitute 03-231)
42-419	Biomaterial/Host Interactions – Fall

BMTE Electives (choose 2)

03-240	Cell Biology - Spring
09-217	Organic Chemistry I - Fall
09-218	Organic Chemistry II - Spring
42-311/27-510	Polymeric Biomaterials - Spring
42-312/27-511	Metallic and Ceramic Biomaterials - Fall
42-413	Biomaterials Interfaces - Spring
42-424	Biological Transport - Spring
42-506	Surgery for Engineers** - Fall/Spring
42-507	Microfluidics - Spring
42-X00	BME Research

**Please note that 42-506 (Surgery for Engineers) and 42-X00 (BME Research) cannot BOTH be used as track electives. You may select one as a track elective.

Courses that count both as BMTE and MSE electives:

42-311/27-510	Polymeric Biomaterials
42-312/27-511	Metallic and Ceramic Biomaterials

Biomechanics (BMEC) Track

BMEC Gateway Course (required)

42-431 Introduction to Biomechanics – Spring

BMEC Electives (choose 3)

42-312/27-511	Metallic and Ceramic Biomaterials - Spring
42-347	Rehabilitation Engineering - Fall
42-424	Biological Transport - Spring
42-441	Cardiovascular Biomechanics
42-444	Medical Devices - Fall
42-506	Surgery for Engineers** - Fall/Spring
42-507	Microfluidics - Spring
42-508	Molecular Bioengineering – Spring
42-645	Cellular Biomechanics - Spring
42-X00	BME Research**
BIOE 1720	Biomechanics II: Biodynamics of Movement (Univ. of Pittsburgh Dept. of Bioengineering)
BIOE 1064	Biomechanics III: Tissues and Organs (Univ. of Pittsburgh Dept. of Engineering)

**Please note that 42-506 (Surgery for Engineers) and 42-X00 (BME Research) cannot BOTH be used as track electives. You may select one for a track elective.

Courses that count both as BMEC and MechE Electives:

42-445/24-415	Special Topics: Microfluidics – intermittent
42-502/24-655	Cellular Biomechanics – intermittent
42-508/24-539	Special Topics in Technology: Molecular Bioengineering Structure, Mechanics & Energetics

Cellular and Molecular Biotechnology (CMBT) Track

CMBT Gateway Course (required):

42-321 Cellular and Molecular Biotechnology

CMBT Track Electives (choose 3)

03-232 Biochemistry - Spring
 03-240 Cell Biology - Spring
 42-422 Bioprocess Design - Spring
 42-424 Biological Transport - Spring
 42-426 Biosensors and BioMEMS - Spring
 42-445 Microfluidics - Spring
 42-502/24-655 Cellular Biomechanics - Spring - intermittent
 42-506 Surgery for Engineers** - Fall/Spring
 42-508 Molecular Bioengineering - Spring
 42-621 Biological Processes in Environmental Systems - Spring
 42-x00 BME Research **

** Please note that 42-506 Surgery for Engineers and 42-X00 (BME Research) cannot BOTH be used as track electives. You may select one as a track elective.

Courses that count both as CMBT and Meche Electives:

42-502/24-655 Cellular Biomechanics - intermittent
 42-445/24-415 Special Topics: Microfluidics - intermittent
 42-508/24-539 Special Topics: Molecular Bioengineering/Special Topics in Technology: Molecular Bioengineering Structure, Mechanics & Energetics - Spring

Courses that count both as CMBT and CHE Electives:

42-508/06-815 Special Topics: Molecular Bioengineering
 42-621/06-621 Biological Processes in Environmental Systems

Minimum number of units to graduate: 401

General Biomedical Engineering (GBME) Track:

- Core courses required
- One gateway course from those listed in the above tracks.
- 42-401 BME Foundations of Design (Fall)
- 42-401 BME Design (Spring)
- Three track elective courses selected from any of those listed with the BIMG, BMTE, BMEC or CMBT tracks above.

Undergraduate Course Requirements

for the Minor

For CIT students

General Requirements: (five courses, minimum of 48 units)

42-101 Introduction to Biomedical Engineering
 (coreq. or prereq.: 03-121)
 42-202 Physiology
 (prereq.: 03-121 or permission of instructor)
 03-121 Modern Biology
 xx-xxx BME track course
 xx-xxx BME track course

For non-CIT students

General Requirements: (six courses, minimum of 60 units).

42-101 Introduction to Biomedical Engineering
 (coreq. or prereq.: 03-121)
 xx-xxx A second Introductory Engineering Course
 42-202 Physiology
 (prereq.: 03-121 or permission of instructor)
 03-121 Modern Biology
 xx-xxx BME track course *
 xx-xxx BME track course **

* This course cannot be a required course in your home department

** This course must be offered by one of the CIT Departments (06-xxx, 12-xxx, 18-xxx, 19-xxx, 24-xxx, 27-xxx or 42-xxx)

Both CIT and non-CIT students may replace one BME track course in the minor program with a research project, either 42-200 Sophomore BME Research, 42-300 Junior BME Research, 42-400 Senior BME Research or 39-500 CIT Honors Thesis, as long as the research project is supervised by a regular or courtesy BME faculty member and the project is conducted for 9 or more units of credit.

Advising

Each student who declares a BME additional major or minor will be assigned a BME faculty member as an academic advisor; for double majors, this may be in addition to an advisor assigned in the second CIT department. Faculty members associated with other departments may also serve as information resources for those students contemplating participation in the double major or minor program. By department, these faculty members include:

Biological Sciences: Profs. Amy Burkert; Robert Murphy
 Chemical Engineering: Profs. Kris Dahl, Michael Domach, Todd Przybycien, Robert Tilton, Steinar Hauan, and James Schneider
 Chemistry: Prof. Newell Washburn
 Civil & Environmental Engineering: Prof. Jeanne VanBriesen
 Electrical & Computer Engineering: Profs. Jelena Kovacevic, Kerem Pekkan, Gustavo Rohde, Stefan Zappe and José Moura
 Materials Science & Engineering: Profs. Newell Washburn and Lisa Porter
 Mechanical Engineering: Profs. Jim Antaki, Conrad Zapanta, and Phil LeDuc

Mrs. Hilda Diamond, located in Doherty Hall 2100, will also help with aspects of advising and attention to details, including student course requirements, scheduling of BME courses and working with departments to avoid conflicts. Coordination of advising with an additional major's second engineering department is essential. Note that for double majors, the second engineering department advisor must approve final schedules. Professor Zapanta and Mrs. Diamond will serve as advisors to BME Minor program students from the SCS and H&SS colleges.

If you are pursuing an additional major in Biomedical Engineering:

1. Always select your Engineering Core courses first: Many times it becomes very difficult to make up these courses, as they will inevitably conflict with required courses expected to be taken in subsequent years. In a few majors, BME substitutions occur for a few courses. If you are ahead of schedule, consult with your advisor about possible options.
2. Make sure you take the BME required (core) courses as soon as possible. Again, the likelihood of a major conflict increases if you wait, as these courses are scheduled so as to minimize conflicts in the year and semester they are most likely to be taken.
3. 42-101 Introduction to Biomedical Engineering should be taken, ideally, in the freshman year. If this is not possible, the fall of the sophomore year is the next best choice.
4. Minimum units to graduate: Additional majors must satisfy the minimum course requirements established by the second major department to graduate.
5. QPA requirements: The QPA for BME core, track and design courses must be 2.00 or better to graduate with the BME double major. In addition, CIT has the following requirement for graduation: "A student must also achieve a cumulative quality point average of 2.00 in a series of core courses, up to a maximum of 184 units, specified by the department. When more than one possibility exists for meeting a specific requirement (e.g., Breadth), the courses will be chosen as to maximize the QPA. Similarly, when a course is retaken, the better grade will be used in the computation of the minimum QPA in the above courses."

Sample schedule for BME-CEE Double Majors in the BMEC Track

Civil Engineering

First Year		Units
	Fall	
12-100	Intro. to Civil & Environmental Engineering	12
21-120	Differential & Integral Calculus	10
33-106	Physics I for Engineers	12
99-101	Computing@Carnegie Mellon	3
xx-xxx	H&SS Elective	9
		46

Spring		Units
xx-xxx	Introduction to Engineering	12
21-122	Integration, Differential Equations, & Approximations	10
33-107	Physics II for Engineers	12
xx-xxx	H&SS Elective	9
		43

Second Year

Fall		Units
12-212	Statics	9
15-100	Introduction/Intermediate Programming	10
21-259	Calculus in Three Dimensions	9
09-101	Intro to Experimental Chemistry	3
09-105	Modern Chemistry I	10
xx-xxx	H&SS Elective	9
		50

Spring		Units
12-231	Solid Mechanics	9
12-232	Solid Mechanics Lab	3
21-260	Differential Equations	9
12-271	Computer Applications in Civil & Environmental Engineering	9
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 1	9
		48

Third Year

Fall		Units
12-301	Civil & Environmental Engineering Projects	9
12-335	Soil Mechanics	9
12-336	Soil Mechanics & Materials Lab	3
12-355	Fluid Mechanics	9
12-356	Fluid Mechanics Lab	3
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 2	9
		51

Spring		Units
12-351	Environmental Engineering	9
12-352	Environmental Engineering Lab	3
27-357	Material Selection	6
12-358	Materials Lab	3
36-220	Engineering Statistics and Quality Control	9
xx-xxx	Elective 3	9
xx-xxx	Elective 4	9
		48

Fourth Year

Fall		Units
12-401	Civil & Environmental Engineering Design	15
12-411	Project Management	9
12-421	Engineering Economics	6
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 5	9
		48

Spring		Units
xx-xxx	H&SS or CFA Elective	9
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 6	9
xx-xxx	Elective 7	9
xx-xxx	Elective 8	9
		45

Civil Engineering and BME

First Year		Units
	Fall	
12-100	Intro. to Civil & Environmental Engineering	12
21-120	Differential & Integral Calculus	10
33-106	Physics I for Engineers	12
99-101	Computing@Carnegie Mellon	3
xx-xxx	General Education Course	9
		46

Spring		Units
42-101	Intro. to Biomedical Engineering	12
21-122	Integration, Differential Equations, & Approximations	10
33-107	Physics II for Engineers	12
03-121	Modern Biology	9
xx-xxx	General Education Course	9
		52

Second Year

Fall		Units
12-212	Statics	9
15-100	Introduction/Intermediate Programming	10
21-259	Calculus in Three Dimensions	9
09-101	Intro to Experimental Chemistry	3
09-105	Modern Chemistry I	10
42-202	Physiology	9
-or-		
42-203	BME Laboratory	9
42-201	Professional Issues in BME	3
		53

Spring		Units
12-231	Solid Mechanics	9
12-232	Solid Mechanics Lab	3
21-260	Differential Equations	9
12-271	Computer Applications in Civil & Environmental Engineering	9
xx-xxx	General Education Course	9
42-202	Physiology	9
-or-		
42-203	BME Laboratory	9
		48

Third Year

Fall		Units
12-301	Civil & Environmental Engineering Projects	9
12-335	Soil Mechanics	9
12-336	Soil Mechanics & Materials Lab	3
12-355	Fluid Mechanics	9
12-356	Fluid Mechanics Lab	3
xx-xxx	H&SS or CFA Elective	9
42-341	Introduction to Biomechanics	9
		51

Spring		Units
12-351	Environmental Engineering	9
12-352	Environmental Engineering Lab	3
27-357	Material Selection	6
12-358	Materials Lab	3
36-220	Engineering Statistics and Quality Control	9
42-4xx	BMEC Track Elective	9
xx-xxx	Elective	9
		48

Fourth Year

Fall		Units
12-401	Civil & Environmental Engineering Design	15
12-411	Project Management	9
12-421	Engineering Economics	6
xx-xxx	H&SS or CFA Elective	9
42-401	Foundations of BME Design	3
42-4xx	BMEC Track Elective	9
		51

Spring		Units
xx-xxx	H&SS or CFA Elective	9
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective	9
42-xxx	BMEC Track Elective	9
42-402	BME Design	9
		45

Minimum number of units required for degree: 394

Sample schedule for BME-CEE Double Majors in the CMBT Track

Civil Engineering
First Year

	Fall	Units
12-100	Intro to Civil & Environmental Eng.	12
21-120	Differential & Integral Calculus	10
33-106	Physics I for Engineers	12
99-101	Computing@Carnegie Mellon	3
xx-xxx	General Education Course	9

46

	Spring	Units
xx-xxx	Introduction to Engineering	12
21-122	Integration, Differential Equations, & Approximations	10
33-107	Physics II for Engineers	12
xx-xxx	H&SS Elective	9

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Second Year

	Fall	Units
12-212	Statics	9
15-100	Introduction/Intermediate Programming	10
21-259	Calculus in Three Dimensions	9
09-101	Intro to Experimental Chemistry	3
09-105	Modern Chemistry I	10
xx-xxx	H&SS Elective	9

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	Spring	Units
12-231	Solid Mechanics	9
12-232	Solid Mechanics Lab	3
21-260	Differential Equations	9
12-271	Computer Applications in Civil & Environmental Engineering	9
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 1	9

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Third Year

	Fall	Units
12-301	Civil & Environmental Engineering Projects	9
12-335	Soil Mechanics	9
12-336	Soil Mechanics & Materials Lab	3
12-355	Fluid Mechanics	9
12-356	Fluid Mechanics Lab	3
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 2	9

51

	Spring	Units
12-351	Environmental Engineering	9
12-352	Environmental Engineering Lab	3
27-357	Material Selection	6
12-358	Materials Lab	3
36-220	Engineering Statistics and Quality Control	9
xx-xxx	Elective 3	9
xx-xxx	Elective 4	9

48

Fourth Year

	Fall	Units
12-401	Civil & Environmental Engineering Design	15
12-411	Project Management	9
12-421	Engineering Economics	6
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 5	9

48

	Spring	Units
xx-xxx	H&SS or CFA Elective	9
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 6	9
xx-xxx	Elective 7	9
xx-xxx	Elective 8	9

45

Civil Engineering and BME
First Year

	Fall	Units
12-100	Intro to Civil & Environmental Eng.	12
21-120	Differential & Integral Calculus	10
33-106	Physics I for Engineers	12
99-101	Computing@Carnegie Mellon	3
xx-xxx	General Education Course	9

46

	Spring	Units
42-101	Intro. to Biomedical Engineering	12
21-122	Integration, Differential Equations, & Approximations	10
33-107	Physics II for Engineers	12
03-121	Modern Biology	9
xx-xxx	General Education Course	9

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Second Year

	Fall	Units
12-212	Statics	9
15-100	Introduction/Intermediate Programming	10
21-259	Calculus in Three Dimensions	9
09-101	Intro to Experimental Chemistry	3
09-105	Modern Chemistry I	10
42-201	Professional Issues in BME	3
42-202	Physiology -or-	9
42-203	BME Laboratory	9

53

	Spring	Units
12-231	Solid Mechanics	9
12-232	Solid Mechanics Lab	3
21-260	Differential Equations	9
12-271	Computer Applications in Civil & Environmental Engineering	9
xx-xxx	General Education Course	9
42-202	Physiology -or-	9
42-203	BME Laboratory	9

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Third Year

	Fall	Units
12-301	Civil & Environmental Engineering Projects	9
12-335	Soil Mechanics	9
12-336	Soil Mechanics & Materials Lab	3
12-355	Fluid Mechanics	9
12-356	Fluid Mechanics Lab	3
xx-xxx	H&SS or CFA Elective	9
42-321	Cellular and Molecular Biotechnology	9

51

	Spring	Units
12-351	Environmental Engineering	9
12-352	Environmental Engineering Lab	3
27-357	Material Selection	6
12-358	Materials Lab	3
36-220	Engineering Statistics and Quality Control	9
42-4xx	CMBT Track Elective	9
xx-xxx	Elective	9

48

Fourth Year

	Fall	Units
12-401	Civil & Environmental Engineering Design	15
12-411	Project Management	9
12-421	Engineering Economics	6
xx-xxx	H&SS or CFA Elective	9
42-401	Foundations of BME Design	3
42-4xx	CMBT Track Elective	9

51

	Spring	Units
xx-xxx	H&SS or CFA Elective	9
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective	9
42-xxx	CMBT Track Elective	9
42-402	BME Design	9

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Minimum number of units required for degree: 394

Sample schedule for ChemE/BME Double Majors in the BMTE Track

Chemical Engineering

First Year		Units
	Fall	
21-120	Differential & Integral Calculus	10
76-xxx	Designated Writing Course	9
99-101	Computing@Carnegie Mellon	3
06-100	Intro. to Chemical Engineering	12
09-105	Modern Chemistry	10
		44

	Spring	Units
21-122	Integration, Differential Equations & Approximations	10
xx-xxx	Intro. to Engineering Course	12
33-106	Physics I for Engineers	12
xx-xxx	General Education Course	9
		43

Second Year

Fall		Units
06-222	Sophomore ChemE Seminar	1
21-259	Calculus in Three Dimensions	9
06-221	Thermodynamics	9
09-106	Modern Chemistry II	10
15-100	Introductory/Intermediate Programming	10
xx-xxx	General Education Course	9
		48

Spring		Units
06-261	Fluid Mechanics I	9
06-262	Math: Methods of Chem. Engineering	12
09-221	Lab I: Introduction to Chemical Analysis	12
33-107	Physics II for Engineers	12
xx-xxx	General Education Course	9
		54

Third Year

Fall		Units
06-321	Chemical Engineering Thermodynamics	9
06-322	Junior ChemE Seminar	2
06-323	Heat and Mass Transfer	9
09-217	Organic Chemistry I	9
09-347	Advanced Physical Chemistry	12
xx-xxx	General Education Course	9
		50

Spring		Units
06-361	Unit Operations of ChemE	9
06-362	Chemical Engineering Process Control	9
06-363	Transport Process Laboratory	6
02-232	Biochemistry	9
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9
		51

Fourth Year

Fall		Units
06-421	Chemical Process System Design	12
06-422	Chemical Reaction Engineering	9
06-423	Unit Operations Laboratory	9
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9
		48

Spring		Units
06-461	Process Design Project	6
06-462	Economics & Optimization	6
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9
		48

Chemical Engineering and BME

First Year		Units
	Fall	
21-120	Differential & Integral Calculus	10
76-xxx	Designated Writing Course	9
99-101	Computing@Carnegie Mellon	3
06-100	Intro to Chemical Engineering	12
09-105	Modern Chemistry	10
		44

	Spring	Units
21-122	Integration, Differential Equations & Approximations	10
42-101	Intro to Biomedical Engineering	12
33-106	Physics I for Engineers	12
03-121	Modern Biology	9
xx-xxx	General Education Course	9
		52

Second Year

Fall		Units
06-222	Sophomore ChemE Seminar	1
21-259	Calculus in Three Dimensions	9
06-221	Thermodynamics	9
09-106	Modern Chemistry II	10
15-100	Introductory/Intermediate Programming	10
42-202	Physiology -or-	9
42-203	BME Laboratory	9
		48

Spring		Units
06-261	Fluid Mechanics I	9
06-262	Math: Methods of Chem. Engineering	12
09-221	Lab I: Introduction to Chemical Analysis	12
33-107	Physics II for Engineers	12
42-201	Professional Issues in BME	3
42-202	Physiology -or-	9
42-203	BME Laboratory	9
		57

Third Year

Fall		Units
06-321	Chemical Engineering Thermodynamics	9
06-323	Heat and Mass Transfer	9
09-217	Organic Chemistry I	9
09-347	Advanced Physical Chemistry	12
xx-xxx	General Education Course	9
		48

Spring		Units
06-361	Unit Operations of ChemE	9
06-362	ChemE Process Control	9
06-363	Transport Process Laboratory	6
03-232	Biochemistry	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
		51

Fourth Year

Fall		Units
06-421	Chemical Process System Design	12
06-422	Chemical Reaction Engineering	9
06-423	Unit Operations Laboratory	9
42-401	Foundations of BME Design	3
42-419	Biomaterials/Host Interactions	9
xx-xxx	General Education Course	9
		51

Spring		Units
06-461	Process Design Project	6
06-462	Economics & Optimization	6
42-402	BME Design	9
xx-xxx	BMTE Track Elective*	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
		48

Minimum no. units to graduate: 399

Sample schedule for ChemE/BME Double Majors in the CMBT Track

Chemical Engineering

First Year

	Fall	Units
21-120	Differential & Integral Calculus	10
76-xxx	Designated Writing Course	9
99-101	Computing@Carnegie Mellon	3
06-100	Intro. to Chemical Engineering	12
09-105	Modern Chemistry	10

44

	Spring	Units
21-122	Integration, Differential Equations & Approximations	10
xx-xxx	Intro. to Engineering Course	12
33-106	Physics I for Engineers	12
xx-xxx	General Education Course	9

43

Second Year

	Fall	Units
06-222	Sophomore ChemE Seminar	1
21-259	Calculus in Three Dimensions	9
06-221	Thermodynamics	9
09-106	Modern Chemistry II	10
15-100	Introductory/Intermediate Programming	10
xx-xxx	General Education Course	9

48

	Spring	Units
06-261	Fluid Mechanics I	9
06-262	Math: Methods of Chem. Engineering	12
09-221	Lab I: Introduction to Chemical Analysis	12
33-107	Physics II for Engineers	12
xx-xxx	General Education Course	9

54

Third Year

	Fall	Units
06-321	Chemical Engineering Thermodynamics	9
06-322	Junior ChemE Seminar	2
06-323	Heat and Mass Transfer	9
09-217	Organic Chemistry I	9
09-347	Advanced Physical Chemistry	12
xx-xxx	General Education Course	9

50

	Spring	Units
06-361	Unit Operations of ChemE	9
06-362	Chemical Engineering Process Control	9
06-363	Transport Process Laboratory	6
02-232	Biochemistry	9
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9

51

Fourth Year

	Fall	Units
06-421	Chemical Process System Design	12
06-422	Chemical Reaction Engineering	9
06-423	Unit Operations Laboratory	9
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9

48

	Spring	Units
06-461	Process Design Project	6
06-462	Economics & Optimization	6
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9

48

Chemical Engineering and BME

First Year

	Fall	Units
21-120	Differential & Integral Calculus	10
76-xxx	Designated Writing Course	9
99-101	Computing@Carnegie Mellon	3
06-100	Intro to Chemical Engineering	12
09-105	Modern Chemistry	10

44

	Spring	Units
21-122	Integration, Differential Equations & Approximations	10
42-101	Intro to Biomedical Engineering	12
33-106	Physics I for Engineers	12
03-121	Modern Biology	9
xx-xxx	General Education Course	9

52

Second Year

	Fall	Units
06-222	Sophomore ChemE Seminar	1
21-259	Calculus in Three Dimensions	9
06-221	Thermodynamics	9
09-106	Modern Chemistry II	10
15-100	Introductory/Intermediate Programming	10
42-202	Physiology -or-	9
42-203	BME Laboratory	9

48

	Spring	Units
06-261	Fluid Mechanics I	9
06-262	Math: Methods of Chem. Engineering	12
09-221	Lab I: Introduction to Chemical Analysis	12
33-107	Physics II for Engineers	12
42-201	Professional Issues in BME	3
42-202	Physiology -or-	9
42-203	BME Laboratory	9

57

Third Year

	Fall	Units
06-321	Chemical Engineering Thermodynamics	9
09-217	Organic Chemistry I	9
06-323	Heat and Mass Transfer	9
09-347	Advanced Physical Chemistry	12
42-321	Cellular and Molecular Biotechnology	9
xx-xxx	General Education Course	9

57

	Spring	Units
06-361	Unit Operations of ChemE	9
06-362	ChemE Process Control	9
06-363	Transport Process Laboratory	6
03-232	Biochemistry	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9

51

Fourth Year

	Fall	Units
06-421	Chemical Process System Design	12
06-422	Chemical Reaction Engineering	9
06-423	Unit Operations Laboratory	9
42-401	Foundations of BME Design	3
42-xxx	CMBT Track Elective	9
xx-xxx	General Education Course	9

51

	Spring	Units
06-461	Process Design Project	6
06-462	Economics & Optimization	6
42-402	BME Design	9
42-xxx	CMBT Track Elective*	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9

48

Minimum no. units to graduate: 408

Sample schedule for ECE/BME Double Majors in the BIMG Track

Electrical & Computer Engineering

First Year		Units
Fall		
18-100	Intro. to ECE	12
15-100	Introductory/Intermediate Programming	10
21-120	Differential and Integral Calculus	10
xx-xxx	General Education Course	9
99-102	Computing@Carnegie Mellon	3
		44

Spring		Units
xx-xxx	Intro. to Engineering Course	12
33-106	Physics I for Engineers	12
21-122	Integration, Differential Equations and Approximation	10
76-xxx	Designated Writing Course	9
		43

Second Year

Fall		Units
18-200	Emerging Trends in ECE	1
18-240	Fundamentals of Computer Engineering	12
21-127	Concepts of Mathematics	9
33-107	Physics II for Engineers	12
xx-xxx	General Education Course	9
		43

Spring		Units
18-202	Mathematical Foundations of Electrical Engineering	12
18-220	Fundamentals of Electrical Engineering	12
15-123	Effective Programming in C and Unix	9
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9
		51

Third Year

Fall		Units
15-213	Introduction to Computer Systems	12
xx-xxx	ECE Breadth Course 1	12
36-217	Probability and Statistics	9
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9
		51

Spring		Units
18-290	Signal and Information Processing	12
18-xxx	ECE Breadth Course 2	12
xx-xxx	Math/Science Elective	9
xx-xxx	Engineering Elective	9
xx-xxx	General Education Course	9
		51

Fourth Year

Fall		Units
18-5xx	Capstone Design	12
xx-xxx	Math/Science Elective 2	9
18-xxx	ECE Depth	12
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9
		51

Spring		Units
18-xxx	ECE Coverage	12
xx-xxx	Free Elective	12
xx-xxx	Free Elective	12
xx-xxx	General Education Course	9
		45

Electrical & Computer Engineering and BME

First Year		Units
Fall		
18-100	Intro. to ECE	12
15-100	Introductory/Intermediate Programming	10
21-120	Differential and Integral Calculus	10
xx-xxx	General Education Course	9
99-102	Computing@Carnegie Mellon	3
		44

Spring		Units
42-101	Introduction to BME	12
33-106	Physics I for Engineers	12
21-122	Integration, Differential Equations and Approximation	10
76-xxx	Designated Writing Course	9
03-121	Modern Biology (core)	9
		52

Second Year

Fall		Units
18-200	Emerging Trends in ECE	1
18-240	Fundamentals of Computer Engineering	12
21-127	Concepts of Mathematics	9
33-107	Physics II for Engineers	12
42-201	Professional Issues in BME	3
42-202	Physiology (core)	9
-or-		
42-203	BME Laboratory	9
		46

Spring		Units
18-202	Mathematical Foundations of Electrical Engineering	12
18-220	Fundamentals of Electrical Engineering	12
15-123	Effective Programming in C and Unix	9
42-202	Physiology	9
-or-		
42-203	BME Laboratory	9
xx-xxx	General Education Course	9
		51

Third Year

Fall		Units
15-213	Introduction to Computer Systems	12
18-396	Signals and Systems	12
36-217	Probability and Statistics	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
		51

Spring		Units
18-290	Signal and Information Processing	12
18-xxx	ECE Breadth Course 2	12
42-xxx	BIMG Track Elective	12
xx-xxx	Math/Science Elective	9
xx-xxx	General Education Course	9
		53

Fourth Year

Fall		Units
18-xxx	ECE Depth	12
42-401	Foundations of BME Design	3
42-xxx	BIMG Track Elective	12
42-xxx	BIMG Track Elective	9
xx-xxx	General Education Course	9
		45

Spring		Units
18-xxx	ECE Coverage	12
18-xxx	ECE Design	12
42-402	BME Design	9
xx-xxx	General Education Course	9
		42

Minimum no. of units to graduate: 384

Sample schedule for MechE/BME Double Majors in the BMEC Track

Mechanical Engineering
First Year

	Fall	Units
21-120	Differential & Integral Calculus	10
24-101	Fundamentals of Mechanical Eng.	12
33-106	Physics for Engineering Students I	12
99-101	Computing@Carnegie Mellon	3
xx-xxx	Writing/Expression Course	9
		46

	Spring	Units
21-122	Integration, Differential Equations, & Approximations	10
xx-xxx	Second Introductory Engineering Course	12
xx-xxx	Restricted Technical Elective	10-13
xx-xxx	General Education Course	9
		41-44

Second Year

	Fall	Units
21-259	Calculus in Three Dimensions	9
24-221	Thermodynamics I	10
24-261	Statics of Deformable Solids	10
xx-xxx	Restricted Technical Elective	10 -13
xx-xxx	General Education Course	9
		48-51

	Spring	Units
21-260	Differential Equations	9
24-231	Fluid Mechanics	10
24-262	Stress Analysis	12
xx-xxx	Restricted Technical Elective	10-13
xx-xxx	General Education Course	9
		50-53

Third Year

	Fall	Units
24-302	Mechanical Engineering Seminar (Fall or Spring)	2
24-311	Numerical Methods	12
24-322	Heat Transfer	10
24-351	Dynamics	10
36-220	Engineering Statistics	9
xx-xxx	General Education Course	9
		50-52

	Spring	Units
24-302	Mechanical Engineering Seminar (Fall or Spring)	2
24-321	Thermal-Fluids Experimentation and Design	12
24-452	Mechanical Systems Experimentation	12
24-370	Engineering Design I	12
xx-xxx	General Education Course	9
		45-47

Fourth Year

	Fall	Units
24-441	Engineering Design II	12
24-452	Mechanical Systems Experimentation	9
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9
		48

	Spring	Units
24-xxx	ME Tech Elective	9
xx-xxx	Free Elective	9
xx-xxx	Free Elective	9
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9
		45

Mechanical Engineering and BME
First Year

	Fall	Units
21-120	Differential & Integral Calculus	10
24-101	Fundamentals of Mechanical Eng.	12
33-106	Physics for Engineering Students I	12
99-101	Computing@Carnegie Mellon	3
xx-xxx	Writing/Expression Course	9
		46

	Spring	Units
21-122	Integration, Differential Equations, & Approximations	10
42-101	Introduction to BME	12
15-100 or		
15-111	Introductory/Intermediate Programming	10
03-121	Modern Biology	9
xx-xxx	General Education Course	9
		50

Second Year

	Fall	Units
21-259	Calculus in Three Dimensions	9
24-221	Thermodynamics I	10
24-261	Statics of Deformable Solids	10
33-107	Physics for Engineering Students II	12
42-201	Professional Issues in BME	3
42-202	Physiology -or-	9
42-203	BME Laboratory	9
		53

	Spring	Units
21-260	Differential Equations	9
24-231	Fluid Mechanics	10
24-262	Stress Analysis	12
09-105	Modern Chemistry I	10
42-202	Physiology -or-	9
42-203	BME Laboratory	9
		50

Third Year

	Fall	Units
24-311	Numerical Methods	12
24-322	Heat Transfer	10
24-351	Dynamics	10
42-341	Introduction to Biomechanics	9
36-220	Engineering Statistics	9
		50

	Spring	Units
24-302	Mechanical Engineering Seminar (Fall or Spring)	2
24-321	Thermal-Fluids Experimentation and Design	12
24-352	Mechanical Systems Experimentation	12
42-502	Cellular Biomechanics -or-	9
42-508	Special Topics: Molecular Bioengineering	9
24-370	Engineering Design I	12
xx-xxx	General Education Course	9
		56

Fourth Year

	Fall	Units
24-441	Engineering Design II	12
24-452	Mechanical Systems Experimentation	9
42-401	Foundations of BME Design	3
42-xxx	BMEC Track Elective*	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
		51

	Spring	Units
42-401	BME Design	9
42-xxx	BMEC Track Elective*	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
		45

Minimum no. of units to graduate: 401

Sample schedule for MechE/BME Double Majors in the CMBT Track

Mechanical Engineering

First Year		Units
Fall		
21-120	Differential & Integral Calculus	10
24-101	Fundamentals of Mechanical Eng.	12
33-106	Physics for Engineering Students I	12
99-101	Computing@Carnegie Mellon	3
xx-xxx	Writing/Expression Course	9
		46

Spring		Units
21-122	Integration, Differential Equations, & Approximations	10
xx-xxx	Second Introductory Engineering Course	12
xx-xxx	Restricted Technical Elective	10-13
xx-xxx	General Education Course	9
		41-44

Second Year

Fall		Units
21-259	Calculus in Three Dimensions	9
24-221	Thermodynamics I	10
24-261	Statics of Deformable Solids	10
xx-xxx	Restricted Technical Elective	10-13
xx-xxx	General Education Course	9
		48-51

Spring		Units
21-260	Differential Equations	9
24-231	Fluid Mechanics	10
24-262	Stress Analysis	12
xx-xxx	Restricted Technical Elective	10-13
xx-xxx	General Education Course	9
		50-53

Third Year

Fall		Units
24-302	Mechanical Engineering Seminar (Fall or Spring)	2
24-311	Numerical Methods	12
24-322	Heat Transfer	10
24-351	Dynamics	10
36-220	Engineering Statistics	9
xx-xxx	General Education Course	9
		50-52

Spring		Units
24-302	Mechanical Engineering Seminar (Fall or Spring)	2
24-321	Thermal-Fluids Experimentation and Design	12
24-452	Mechanical Systems Experimentation	12
24-370	Engineering Design I	12
xx-xxx	General Education Course	9
		45-47

Fourth Year

Fall		Units
24-441	Engineering Design II	12
24-452	Mechanical Systems Experimentation	9
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9
		48

Spring		Units
24-xxx	ME Tech Elective	9
xx-xxx	Free Elective	9
xx-xxx	Free Elective	9
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9
		45

Mechanical Engineering and BME

First Year		Units
Fall		
21-120	Differential & Integral Calculus	10
24-101	Fundamentals of Mechanical Eng.	12
33-106	Physics for Engineering Students I	12
99-101	Computing@Carnegie Mellon	3
xx-xxx	Writing/Expression Course	9
		46

Spring		Units
21-122	Integration, Differential Equations, & Approximations	10
42-101	Introduction to BME	12
15-100 or		
15-111	Introductory/Intermediate Programming	10
03-121	Modern Biology	9
xx-xxx	General Education Course	9
		50

Second Year

Fall		Units
21-259	Calculus in Three Dimensions	9
24-221	Thermodynamics I	10
24-261	Statics of Deformable Solids	10
33-107	Physics for Engineering Students II	12
42-201	Professional Issues in BME	3
42-202	Physiology -or-	9
42-203	BME Laboratory	9
		53

Spring		Units
21-260	Differential Equations	9
24-231	Fluid Mechanics	10
24-262	Stress Analysis	12
09-105	Modern Chemistry I	10
42-202	Physiology -or-	9
42-203	BME Laboratory	9
		50

Third Year

Fall		Units
24-311	Numerical Methods	12
24-322	Heat Transfer	10
24-351	Dynamics	10
42-321	Cellular & Molecular Biotech	9
36-220	Engineering Statistics	9
		50

Spring		Units
24-302	Mechanical Engineering Seminar (Fall or Spring)	2
24-321	Thermal-Fluids Experimentation and Design	12
24-452	Mechanical Systems Experimentation	12
42-502	Cellular Biomechanics -or-	9
42-508	Special Topics: Molecular Bioengineering	9
24-370	Engineering Design I	12
xx-xxx	General Education Course	9
		56

Fourth Year

Fall		Units
24-441	Engineering Design II	12
24-452	Mechanical Systems Experimentation	9
42-401	Foundations of BME Design	3
42-xxx	CMBT Track Elective*	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
		51

Spring		Units
42-402	BME Design	9
42-xxx	CMBT Track Elective*	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
		45

Minimum no. of units to graduate: 401

Sample schedule for MSE/BME Double Majors in the BMTE Track

Materials Science & Engineering
First Year

	Fall	Units
21-120	Differential & Integral Calculus	10
33-106	Physics I for Engineers	12
27-100	Materials in Engineering	12
xx-xxx	General Education Elective	9
		43
	Spring	Units
21-122	Integration, Differential Equations, & Approximations	10
15-100	Intro/Intermediate Programming	10
99-101	Computing@Carnegie Mellon	3
xx-xxx	Introductory Engineering Elective	12
xx-xxx	General Education Elective	9
		44

Second Year

	Fall	Units
21-259	Calculus in Three Dimensions	9
27-201	Structure of Materials	9
27-202	Defects in Materials	9
27-215	Thermodynamics of Materials	12
27-299	Professional Development I	1
33-107	Physics II for Engineers	12
21-126	Intro to Mathematical Software	3
		55
	Spring	Units
09-101	Introduction to Experimental Chemistry	3
09-105	Modern Chemistry I	10
21-260	Differential Equations	9
27-205	Materials Characterization Lab	3
27-216	Transport in Materials	9
27-217	Phase Relations and Diagrams	12
xx-xxx	General Education Course	9
		55

Third Year

	Fall	Units
27-399	Professional Development II	1
27-301	Microstructure and Properties I	9
33-225	Quantum Physics & Structure of Matter <i>OR</i>	9
09-217	Organic Chemistry I <i>OR</i>	9
03-121	Modern Biology	9
xx-xxx	Free Elective	9
27-xxx	MSE Restricted Elective	9
xx-xxx	General Education Elective	9
		46
	Spring	Units
27-367	Selection and Performance	6
36-220	Engineering Statistics & Quality Control	9
xx-xxx	General Education Elective	9
xx-xxx	Free Elective	9
xx-xxx	Free Elective	9
27-xxx	MSE Restricted Elective	9
		51

Fourth Year

	Fall	Units
27-401	MSE Capstone (1)	12
27-499	Professional Development III	1
xx-xxx	Free Elective	9
xx-xxx	General Education Elective	9
xx-xxx	General Education Elective	9
27-xxx	MSE Restricted Elective	9
		49
	Spring	Units
xx-xxx	Free Elective	9
27-xxx	MSE Restricted Elective	9
27-xxx	MSE Restricted Elective	9
xx-xxx	General Education Elective	9
		36

Materials Science & Engineering and BME
First Year

	Fall	Units
21-120	Differential & Integral Calculus	10
33-106	Physics I for Engineers	12
27-100	Materials in Engineering	12
03-121	Modern Biology	9
		43
	Spring	Units
21-122	Integration, Differential Equations, & Approximations	10
15-100	Intro/Intermediate Programming	10
99-101	Computing@Carnegie Mellon	3
42-101	Intro to Biomedical Engineering	12
33-107	Physics II for Engineers	12
		47

Second Year

	Fall	Units
21-259	Calculus in Three Dimensions	9
27-201	Structure of Materials	9
27-202	Defects in Materials	9
27-215	Thermodynamics of Materials	12
27-299	Professional Development I	1
21-126	Intro to Mathematical Software	3
42-201	Professional Issues in BME	3
42-202	Physiology <i>-or-</i>	9
42-203	BME Lab	9
		55
	Spring	Units
09-101	Introduction to Experimental Chemistry	3
09-105	Modern Chemistry I	10
21-260	Differential Equations	9
27-205	Materials Characterization Lab	3
27-216	Transport in Materials	9
27-217	Phase Relations and Diagrams	12
42-202	Physiology <i>-or-</i>	9
42-203	BME Lab	9
		55

Third Year

	Fall	Units
27-399	Professional Development II	1
27-301	Microstructure and Properties I	9
03-231	Biochemistry	9
27-xxx	MSE Restricted Elective	9
xx-xxx	General Education Elective	9
xx-xxx	General Education Course	9
		46
	Spring	Units
27-367	Selection and Performance	6
36-220	Engineering Statistics & Quality Control	9
42-xxx	BMTE Track Elective	9
xx-xxx	General Education Elective	9
xx-xxx	General Education Elective	9
27-xxx	MSE Restricted Elective	9
		51

Fourth Year

	Fall	Units
27-401	MSE Capstone (1)	12
27-499	Professional Development III	1
42-401	Foundations of BME Design	3
42-419	Host/Biomaterial Interactions	9
xx-xxx	General Education Elective	9
xx-xxx	General Education Elective	9
27-xxx	MSE Restricted Elective	9
		52
	Spring	Units
27-xxx	MSE Restricted Elective	9
42-402	BME Design	9
42-xxx	BMTE Track Elective	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
		45

Minimum no. of units to graduate: 394

Department of Chemical Engineering

Andrew Gellman, Head
Office: Doherty Hall 1107

Chemical engineering is a broad discipline based on chemistry, mathematics, physics and biology that applies the principles of engineering science and process systems engineering to the development and commercialization of new products and processes. Engineering science provides experimental and theoretical models for predicting the behavior of fluid flow and heat transfer in materials and biological systems, as well as chemical reactions and mass transfers that take place in multi-component mixtures. Process systems engineering provides methodologies for the systematic design and analysis of processes, including their control, safety, and environmental impact. The department emphasizes the basic principles of engineering science and process systems engineering through problem solving, and it strives to broaden the experience of students by offering a significant number of electives, undergraduate research projects, an integrated masters degree, industrial internships and study abroad programs, all of which benefit from our strong industrial ties.

A career in chemical engineering offers challenging and well-compensated positions in a wide variety of growth industries. Graduates may supervise the operation of chemical plants, redesign chemical processes for pollution prevention, or be involved in the research and development of new products or processes in high technology areas. These activities require knowledge of chemical reactions and catalysis, separation technologies and energy recovery systems, all of which are thoroughly presented in our curriculum. In the petroleum industry, for example, our national need for fuels demands well-trained chemical engineers in catalysis. A significant number of chemical engineers are also hired by industries associated with colloids (fine particles), polymers (plastics and resins), and coatings (e.g., paint, integrated circuits). Opportunities exist in biotechnology, the computer industry, environmental firms, and consulting companies. Other examples include the processing of advanced polymeric systems, thin films for the semiconductor and data storage industry, and chip fabrication. A growing number of consulting companies hire chemical engineers to develop computer software for the simulation and real-time optimization of chemical processes, for predicting how toxic chemicals are dispersed and degraded in soils and in the atmosphere, and for evaluating the economic feasibility of industrial projects. The diversity of career opportunities arises from the depth and breadth of the curriculum. For instance, the pharmaceutical industry recruits chemical engineers who possess a combined expertise in process engineering and biochemistry/molecular biology.

The curriculum emphasizes the fundamentals of physical, chemical, and biological phenomena, mathematical modeling, exposure to biotechnology and problem solving techniques. These provide rigorous preparation for immediate employment after graduation, or a strong basis for graduate school. The depth and breadth of coursework makes chemical engineering an excellent major for students interested in either medical or business schools. Computing is integrated throughout the curriculum, and extensive use is made of mathematical modeling and simulation software in the department's Computational Laboratory. The Robert Rothfus Laboratory and Lubrizol Analytical Laboratory feature state-of-the-art experiments that illustrate applications in safety, environmental, product development, and computerized data acquisition and control.

The objectives for the department are that graduates of the department will obtain employment or attend graduate school, will advance in their chosen careers, and will be productive and fulfilled professionals throughout their careers. The curriculum and programs are developed to prepare students to attain these objectives.

Students majoring in chemical engineering learn the science and engineering that govern chemical processing systems. Fundamental principles, problem solving, systems analysis and design, development of self-confidence, and communication skills are emphasized. Students are made aware of modern tools, industrial needs and societal issues. This combination of fundamental knowledge and skills provides a firm foundation for future learning and career growth. The goal of the department is to produce

students who will become leaders in their careers. Students who complete the curriculum will have attained:

- mathematics, science, and engineering skills, and the ability to apply them to solve engineering problems,
- the ability to design and conduct experiments and interpret data,
- the ability to design a component or system, within realistic constraints,
- the ability to identify, formulate and solve engineering problems,
- the ability to use modern engineering tools,
- the ability to function on teams,
- an understanding of personal and professional ethics,
- an ability to communicate effectively,
- an ability to understand impact of engineering in a global/societal context,
- an appreciation and capability for life-long learning,
- a knowledge of contemporary issues facing engineers.

The department offers a number of special programs for students majoring in Chemical Engineering. In addition to the double majors or minors offered by the College of Engineering such as Biomedical Engineering and Manufacturing Management & Consulting, students may choose a minor in Colloids, Polymers, and Surfaces. Undergraduate research projects are also available in the areas of bioengineering, complex fluids engineering, environmental engineering, process systems engineering, and solid state materials. Students may participate in study abroad programs during their Junior year. In addition to the University program with EPFL in Switzerland and ITESM Monterey in Mexico, the department provides its own exchange programs with the University of Aachen in Germany and Imperial College in London, Great Britain. The latter two programs are jointly organized with industrial partners, i.e., Bayer Corporation, Air Products & Chemicals, and Procter & Gamble respectively. Students may also participate in Practical Internships for Senior Chemical Engineering Students, a one-year industrial internship program offered between the Junior and Senior years. Finally, qualified students may enroll in our Master of Chemical Engineering program. This degree is typically completed in the fifth year. However, depending on the number of advanced placement courses and course load at Carnegie Mellon, this degree could be awarded during the B.S. graduation, or after one additional semester.

Curriculum

First Year

	Fall	Units
21-120	Differential and Integral Calculus	10
76-xxx	Designated Writing/Expression Course	9
99-101	Computing @ Carnegie Mellon	3
06-100	Intro to Chemical Engineering	12
09-105	Intro to Modern Chemistry	10
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	Spring	
21-122	Integration, Differential Equation & Approximation	10
xx-100/101	Introductory Engineering Elective (other than ChE)	12
33-106	Physics for Engineering Students I	12
xx-xxx	General Education Course	9
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Second Year

	Fall	Units
21-259	Calculus in Three-Dimensions	9
06-221	Thermodynamics	9
06-222	Sophomore Chemical Engineering Seminar	1
09-106	Modern Chemistry II	10
xx-xxx	Computer Sci./Physics II*	10 or 12
xx-xxx	General Education Course	9

Spring		
06-261	Fluid Mechanics	9
06-262	Mathematical Methods of Chemical Engineering	12
09-221	Lab I: Introduction to Chemical Analysis	12
xx-xxx	Physics II/Computer Sci.*	12 or 10
xx-xxx	General Education Course	9

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* Computer Science/Physics II: Students should complete 15-100 (Introductory/ Intermediate Programming) as well as 33-107 (Physics for Engineering Students II) by the end of the Sophomore year. The recommended sequence is 33-106 / 107 for engineering students, however, 33-111 / 112 or 33-131 / 132 will also meet the CIT Physics requirement.

For those students who have not taken 06-100 as one of the two Introductory Engineering Electives, 06-100 should be taken in the Fall Semester of the Sophomore year. The General Education Course normally taken during that semester may be postponed until the Junior year. These students should consult with their faculty advisors as soon as possible.

At the end of the Sophomore year, a student should have completed the following required basic science and computer science courses.

09-105	Introduction to Modern Chemistry	10
09-106	Modern Chemistry II	10
09-221	Lab I: Introduction to Chemical Analysis	12
15-100	Introductory/Intermediate Programming	10
33-106	Physics for Engineering Students I	12
33-107	Physics for Engineering Students II	12
99-10x	Computing @ Carnegie Mellon	3

Third Year

Fall		Units
06-321	Chemical Engineering Thermodynamics	9
06-322	Junior Chemical Engineering Seminar	2
06-323	Heat and Mass Transfer	9
09-217	Organic Chemistry I	9
09-347	Advanced Physical Chemistry	12
xx-xxx	General Education Course	9

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Spring		Units
06-361	Unit Operations of Chemical Engineering	9
06-362	Chemical Engineering Process Control	9
06-363	Transport Processes Laboratory	6
03-232	Biochemistry**	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9

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Fourth Year

Fall		Units
06-421	Chemical Process Systems Design	12
06-422	Chemical Reaction Engineering	9
06-423	Unit Operations Laboratory	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9

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Spring		Units
06-462	Optimization Modeling and Algorithms	6
06-463	Chemical Product Design	6
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9

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** Students pursuing a Chemical Engineering/Engineering and Public Policy double major are waived from taking the Biochemistry Elective. They will take 36-220.

Notes:

- In addition to the graduation requirement of an overall QPA of 2.0 (not counting the First Year), the Department of Chemical Engineering requires a cumulative QPA of 2.0 in all chemical engineering courses (all those numbered 06-xxx).
- Minimum number of units required for graduation: 386.
- Overloads are permitted only for students maintaining a QPA of 3.0 or better during the preceding semester.

4. Electives: To obtain a Bachelor of Science degree in Chemical Engineering, students must complete 06-100 and one other Introductory Engineering Elective. There are also five Unrestricted Electives. At most, 9 units of ROTC or Physical Education can be counted toward these electives. Students must discuss choice of electives with their faculty advisors.

5. Undergraduate Research: Independent research projects are available by arrangement with a faculty advisor. Many students conduct these research projects for elective credit by enrolling in 06-200, 300, or 400 (Sophomore, Junior, or Senior Research Projects) or 39-500 (CIT Honors Research) for eligible Seniors.

The following two tracks have been designed as thematic guidelines. Students are not required to follow either of these tracks. They may take courses from both tracks and they may take courses that are not listed in either track. The Process Systems Track is designed for students interested in focusing on the design and optimization of chemical processes. The Chemical Engineering Sciences Track is designed for students interested in the scientific principles underlying the fabrication and processing of synthetic and/or biological materials.

Some electives contain elements of both tracks and are therefore listed under each. Undergraduate research projects that fit either track are available by arrangement with a faculty advisor.

Advanced undergraduates may also take Chemical Engineering graduate courses (600+level).

Process Systems Track

06-200, 300, or 400	Sophomore, Junior, or Senior Research Projects
or	
39-500	CIT Honors Research
06-606	Computational Methods for Large Scale Process Design and Analysis
06-608	Safety Issues in Science and Engineering Practice
06-619	Semiconductor Processing Technology
06-630	Atmospheric Chemistry Air Pollution and Global Change
06-708	Advanced Process Dynamics and Control
06-713	Mathematical Techniques in Chemical Engineering
06-715	Advanced Process Synthesis
06-717	Biotechnology and Environmental Processes
06-720	Advanced Process Systems Engineering
06-722	Bio Process Design
12-271	Introduction to Computer Applications in Civil & Environmental Engineering
12-411	Engineering Economics
12-651	Air Quality Engineering
15-111	Intermediate/Advanced Programming
15-200	Advanced Programming/Practicum
15-211	Fundamental Data Structures and Algorithms
18-470	Fundamentals of Control
19-424	Energy and the Environment
21-127	Concepts of Mathematics
21-292	Operations Research I
24-451	Feedback Control Systems
27-322	Processing of Metals
36-220	Engineering Statistics and Quality Control
70-371	Production/Operations Management
70-391	Finance

Chemical Engineering Sciences Track

03-240	Cell Biology
03-231	Biochemistry I
03-330	Genetics
03-380	Virology
03-438	Physical Biochemistry
03-441	Molecular Biology of Prokaryotes
03-442	Molecular Biology
06-200, 300, or 400	Sophomore, Junior, or Senior Research Projects (or 39-500 CIT Honors Research)
06-426	Experimental Colloid Surface Science
06-466	Experimental Polymer Science
06-607	Physical Chemistry of Colloids and Surfaces
06-608	Safety Issues in Science and Engineering Practice
06-609/ 09-509	Physical Chemistry of Macromolecules
06-610/ 09-545	Rheology and Structure of Complex Fluids
06-619	Semiconductor Processing Technology
06-620	Global Atmospheric Chemistry-
06-640	Principles and Applications of Molecular Simulation

06-702	Advanced Reaction Kinetics
06-703	Advanced Fluid Dynamics
06-704	Advanced Heat and Mass Transfer
06-705	Advanced Chemical Engineering Thermodynamics
06-712	Colloids and Dispersions
06-713	Mathematical Techniques in Chemical Engineering
06-714	Surfaces and Absorption
06-716	Electrochemical Engineering
06-717	Biotechnology and Environmental Processes
06-722	Bio Process Design
09-348	Inorganic Chemistry
09-510	Introduction to Green Chemistry
12-651	Air Quality Engineering
21-372	Partial Differential Equations
24-321	Thermal-Fluids Engineering
27-357	Intro to Materials Selection
33-107	Physics for Engineering Students II
33-211	Physics III: Modern Essentials
33-225	Quantum Physics and Structure of Matter
33-228	Electronics I
42-202	Physiology
42-424	Biological Transport

Double Major in Engineering and Public Policy (EPP)

Students may pursue a double major in Chemical Engineering and EPP. This double major is very flexible, built around Electives, Social Analysis, Probability and Statistics courses, and projects. Specific course choices should be discussed with a faculty advisor or an EPP faculty representative.

Double Major in Biomedical Engineering (BME)

Students may pursue a double major in Chemical Engineering and BME. Specific course choices should be discussed with a faculty advisor or a BME faculty representative.

Minors with a B.S. in Chemical Engineering

Chemical Engineering students are eligible for any CIT Designated Minor. Those minors that are especially well suited to Chemical Engineers include Biomedical Engineering, Electronic Materials, Engineering Design, Environmental Engineering, Data Storage Systems Technology, and Automation and Control Engineering. The minor requirements may be fulfilled with electives. Other minors, such as the Manufacturing Management and Consulting minor in association with the Tepper School of Business, are also available outside of CIT. These should be discussed with a faculty advisor.

Minor in Colloids, Polymers, and Surfaces (CPS)

Historically, the CPS coursework sequence has had a long-standing popularity among chemical engineering students. A detailed description of the minor can be found in the CIT Minors section of this catalog, or ask your Chemical Engineering faculty advisor or the Director of CPS. Chemical Engineering students may use four of their electives to obtain the CPS minor. This is a sequence of closely related courses that explore the science and engineering of polymeric materials, particulates, microstructured fluids, and interfacially engineered materials. Completion of the following five courses constitutes the CPS minor:

06-221	Thermodynamics	9
06-607	Physical Chemistry of Colloids and Surfaces	9
06-426	Experimental Colloid and Surface Science	9
06-466	Experimental Polymer Science	9
06-609	Physical Chemistry of Macromolecules	9
	(cross-listed as 09-509)	

Typically 06-607 is taken in the Spring of the Junior year, while 06-609/09-509, 06-426 and 06-466 are taken during the Senior year.

Practical Internships for Senior Chemical Engineering Students (PISCES)

Chemical Engineering students may apply in the fall of their Junior year for a salaried, one-year PISCES with a partner company. Admitted students begin their internships after completion of the Junior year. Following the internship, students return to complete their Senior year. There are several advantages of a one full-year internship, including the opportunity to gain a breadth of professional experience that is not generally possible in a shorter program, more opportunity to make important contributions to the partner company, and the opportunity to complete Senior year courses in their normal sequence with no need for curriculum rearrangements. Interested students should consult with their faculty advisors.

International Chemical Engineering Exchange Programs

Chemical Engineering students may apply during their Sophomore year to spend their Junior year at the University of Aachen in Germany or at Imperial College in London, Great Britain. Students should register for 06-050 - Study Abroad, Fall and/or 06-051 - Study Abroad, Spring. A summer exchange program in Dortmund, Germany is also available. These exchange programs provide a great opportunity for students to obtain international experience while taking courses very similar to those offered at Carnegie Mellon. Students considering any of these programs should consult with their faculty advisors, and students considering the Aachen program in particular are advised to take at least one introductory German course before or during their Sophomore year.

Fifth Year Master of Chemical Engineering (MChE)

This degree offers qualified undergraduate students the opportunity to obtain a Masters degree in Chemical Engineering in less than one academic year. The goal of the program is to produce skilled engineers who will have a deeper understanding of the fundamentals of chemical engineering as well as a broader set of professional skills and exposure to other technical disciplines. The MChE degree requires the completion of at least 96 units, with a cumulative QPA of 3.0. Junior and Senior undergraduates from the department may apply to the MChE program if they have an overall QPA of 3.0. Three letters of recommendation are also required. The deadline for application is February 1 for the Fall semester and October 15 for the Spring semester. All applications should be submitted to the Graduate Admissions Committee of Chemical Engineering.

Faculty

- JOHN L. ANDERSON, Adjunct Professor of Chemical Engineering— Ph.D., University of Illinois; Carnegie Mellon, 1976—.
- LORENZ T. BIEGLER, Bayer Professor of Chemical Engineering — Ph.D., University of Wisconsin; Carnegie Mellon, 1981—.
- KRIS N. DAHL, Assistant Professor of Chemical Engineering – Ph.D., University of Pennsylvania; Carnegie Mellon, 2006 —.
- MICHAEL M. DOMACH, Professor of Chemical Engineering — Ph.D., Cornell University; Carnegie Mellon, 1983—.
- NEIL M. DONAHUE, Professor of Chemical Engineering and Chemistry— Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2000—.
- ANDREW J. GELLMAN, Lord Professor of Chemical Engineering, Head of Department — Ph.D., University of California, Berkeley; Carnegie Mellon, 1992—.
- IGNACIO E. GROSSMANN, University Dean Professor of Chemical Engineering — Ph.D., Imperial College, University of London; Carnegie Mellon, 1979—.
- STEINAR HAUAN, Associate Professor of Chemical Engineering — Ph.D., Norwegian Institute of Science and Technology; Carnegie Mellon, 1999—.
- MOHAMMAD F. ISLAM, Assistant Professor of Chemical Engineering – Ph.D., Lehigh University; Carnegie Mellon, 2005—.
- ANNETTE M. JACOBSON, Teaching Professor of Chemical Engineering and Director of Colloids, Polymers, and Surfaces Program — Ph.D., Carnegie Mellon; Carnegie Mellon, 1988—.
- MYUNG S. JHON, Professor of Chemical Engineering — Ph.D., University of Chicago; Carnegie Mellon, 1980—.
- JOHN KITCHIN, Assistant Professor of Chemical Engineering – Ph.D., University of Delaware; Carnegie Mellon, 2006—.
- EDMOND I. KO, Adjunct Professor of Chemical Engineering — Ph.D., Stanford University; Carnegie Mellon, 1980—.
- KUN LI, Professor Emeritus of Chemical Engineering — Sc.D., Carnegie Mellon University; Carnegie Mellon, 1962—.
- JAMES B. MILLER, Research Scientist – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2006 —.
- SPYROS N. PANDIS, Research Professor of Chemical Engineering and Engineering and Public Policy — Ph.D., California Institute of Technology; Carnegie Mellon, 1993—.
- DENNIS C. PRIEVE, Gulf Professor of Chemical Engineering — Ph.D., University of Delaware; Carnegie Mellon, 1974—.
- TODD M. PRZYBYCIEN, Professor of Chemical Engineering and Biomedical Engineering — Ph.D., California Institute of Technology; Carnegie Mellon, 1998—.
- NIKOLAOS V. SAHINIDIS, John E. Swearingen Professor of Chemical Engineering — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2007—.
- JAMES W. SCHNEIDER, Professor of Chemical Engineering — Ph.D., University of Minnesota; Carnegie Mellon, 1999—.
- PAUL J. SIDES, Professor of Chemical Engineering — Ph.D., University of California, Berkeley; Carnegie Mellon, 1981—.
- ROBERT D. TILTON, Professor of Chemical Engineering — Ph.D., Stanford University; Carnegie Mellon, 1992—.
- HERBERT L. TOOR, Emeritus Professor of Chemical Engineering — Ph.D., Northwestern University; Carnegie Mellon, 1953—.
- LYNN M. WALKER, Professor of Chemical Engineering — Ph.D., University of Delaware; Carnegie Mellon, 1997—.
- ARTHUR W. WESTERBERG, Emeritus, University Professor of Chemical Engineering — Ph.D., DIC, Imperial College, University of London; Carnegie Mellon, 1976—.
- LEE R. WHITE, Professor of Chemical Engineering — Ph.D., Australian National University; Carnegie Mellon, 1998—.
- B. ERIK YDSTIE, Professor of Chemical Engineering — Ph.D., Imperial College, University of London; Carnegie Mellon, 1992—.

Department of Civil and Environmental Engineering

James H. Garrett Jr., Head
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The role of civil and environmental engineers, in the broadest sense, is to apply technology to meet society's needs. Civil engineers plan, design, and manage facilities used daily by the public and industry, such as buildings, airports, water supply and waste management systems. They work at the intersection of the built, natural and virtual environments. Today's civil and environmental engineers are also called upon by government and industry to provide leadership on complex technical and societal issues such as demands for infrastructure improvement in our cities, remediation of hazardous waste sites, provision of safe drinking water, and incorporation of environmental safeguards in new designs. Civil and Environmental Engineering requires broad technical training and strong communication skills because of the complexity of large projects and the attendant interactions with engineers in other fields, lawyers, politicians, and the public. Carnegie Mellon's curriculum is intended to provide this versatility for professional practice in civil and environmental engineering or as a foundation for other professional pursuits.

The Department of Civil and Environmental Engineering offers a wide spectrum of opportunities for direct entry into the engineering profession, for graduate education in engineering, or entry into various other professions. While maintaining its emphasis on the fundamental understanding of the behavior of constructed facilities through the application of the physical sciences and mathematics, the curriculum has continually evolved in directions that exploit advances in technology. The methods of engineering design are introduced in the freshman year and are emphasized throughout the curriculum in both traditional and open-ended project-oriented courses. The basic undergraduate degree program leads to a B.S. in Civil Engineering. Students with a specific interest in Environmental Engineering are advised to undertake the Minor in Environmental Engineering.

Central to the evolution of technology and its impact on engineering practice is the increased emphasis on computer-aided engineering. Several courses on computer methods are required in the curriculum, and virtually every course offered by the department requires the use of computers in applications of either design or analysis. Our curriculum emphasizes the development of scientific inquiry with the perspective of social, economic and institutional developments. For graduates who wish to enter directly the engineering profession in such specialties as structural engineering, construction, or environmental engineering, this approach to teaching allows application of the most advanced technological developments. Others who wish to pursue graduate study are prepared to engage in research on the highest level, either in traditional specialties or in emerging fields such as green design. Historically, some graduates also have found their undergraduate preparation highly suited for entry into graduate schools of business, law and medicine.

A student may choose to concentrate in one of the specialty areas in Civil Engineering, to pursue a minor in one of the CIT designated minor programs, or to design a double major or double degree program. The specialty areas offered by the Civil and Environmental Engineering Department are described in this section. The CIT designated minor programs can be found under the Carnegie Institute of Technology section. The double-major requirements with Biomedical Engineering and with Engineering and Public Policy are described in the curriculum specified by those departments. Other double-major programs selected by recent graduates include computer science, economics, mathematics, business, architecture, history, and foreign languages. Each student should have well defined objectives in selecting courses leading to a specialty, a minor or a double major.

Educational Objectives

The objectives of the Bachelor of Science in Civil Engineering curriculum are to develop:

- Graduates effectively tackle both routine and cutting-edge professional challenges at the intersections of the built, natural, and information environments;

- Graduates are successful and recognized as innovative and adaptive leaders in academic research, government service and private sector activity, over a wide range of engineering and non engineering professions, both in the U.S. and internationally; and
- Graduates use skills learned during their undergraduate education as leaders of their professional and social communities — problem finding/modeling/solving; critical and systems-level thinking; ethical reasoning; written, oral and graphical communications; collaborative team-building and problem solving; and self- and life-long learning.

The Civil Engineering curriculum is intended to allow ample opportunity for students to pursue areas of personal interest. The opportunity for self-exploration requires careful advising to gain meaningful educational experiences. We believe that design and team working experiences should occur at regular intervals in the curriculum, and that graduates should have appropriate "hands on" experience in laboratories and projects. Students are encouraged to participate in research projects and to pursue study or work abroad. By the end of the B.S. program, students should have a variety of abilities and skills:

- an ability to apply knowledge of mathematics (specifically, differential equations and probability and statistics) science (specifically, calculus-based physics and general chemistry) and engineering to practice and problem solving
- an ability to design and conduct experiments as well as to analyze critically and interpret data in environmental engineering, solid mechanics, fluid mechanics and soil mechanics
- an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- an ability to function on multi-disciplinary teams
- an ability to identify, formulate and solve civil engineering problems
- an understanding of professional and ethical responsibility
- an ability to communicate effectively in graphics, speech and words
- the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context
- recognition of the need for and an ability to engage in lifelong learning
- knowledge of contemporary issues relevant to engineering practice
- an ability to use the techniques, skills and modern engineering tools necessary for civil engineering practice
- an ability to apply knowledge in environmental engineering
- an ability to apply knowledge in structural engineering
- an ability to apply knowledge in construction and management
- an ability to apply knowledge in civil engineering
- an ability to explain basic concepts in management, business, public policy, leadership, and the importance of professional licensure

The curriculum has been designed, and is periodically evaluated and refined, to provide students instruction and experiences that lead to the development of these abilities and skills.

Curriculum

All students admitted to CIT are not required to declare a major until the end of the freshman year, and may have selected a variety of Introductory Engineering Electives and associated Restricted Technical Electives within the common foundation specified for freshmen in CIT. Regardless of this selection in the freshman year, a civil engineering major is expected to have completed, in addition to 12-100 Introduction to Civil and Environmental Engineering, the following Restricted Technical Electives by the end of the sophomore year:

09-105	Modern Chemistry I	10
09-101	Intro to Experimental Chemistry	3
15-100	Intro to Programming & Computer Science	10
21-120	Differential and Integral Calculus	10
21-122	Integration, Differential Equations & Approximations	10
33-106	Physics for Engineering Students I	12
33-107	Physics for Engineering Students II	12

Appearing below is the recommended four-year program of study for the BS in civil engineering. Advising and formulation of appropriate programs is available through the department for transfer students, students with advanced placement, or students wishing to study overseas.

Freshman Year

		Units
	Fall	
12-100	Introduction to Civil and Environmental Engineering	12
21-120	Differential and Integral Calculus	10
33-106	Physics for Engineering Students I	12
99-10x	Computing @ Carnegie Mellon	3
xx-xxx	H&SS Elective	9

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	Spring	
xx-xxx	Introduction to Engineering (other than CEE)	12
21-122	Integration, Differential Equations & Approximations	10
33-107	Physics for Engineering Students II	12
xx-xxx	H&SS Elective	9

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Sophomore Year

		Units
	Fall	
12-212	Statics	9
15-100	Introductory/Intermediate Programming	10
21-259	Calculus in Three Dimensions	9
09-101	Intro to Experimental Chemistry	3
09-105	Modern Chemistry I	10
xx-xxx	H&SS Elective	9

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	Spring	
12-231	Solid Mechanics	9
12-232	Solid Mechanics Lab	3
12-271	Intro Computer Apps in Civil & Environmental Engr	9
21-260	Differential Equations	9
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 1	9

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*Notes: If a student takes an Introduction to Engineering course which has a co-requisite other than Physics II, the co-requisite (either 15-100 or 09-105 and 09-101) should be taken in the freshman year while Physics II will fill the respective slot in the sophomore year.

Since CIT freshmen are not required to select a major, the above curriculum is based on the assumption that a potential CEE student is likely to select 12-100 as one of the two Introduction to Engineering courses in the freshman year. Otherwise, incoming sophomores should take 12-100 in the fall in lieu of Modern Chemistry or the H&SS elective.

Junior Year

		Units
	Fall	
12-301	Civil and Environmental Engineering Projects	9
12-335	Soil Mechanics	9
12-336	Soil Mechanics Lab	3
12-355	Fluid Mechanics	9
12-356	Fluid Mechanics Lab	3
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 2	9

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Spring

12-351	Introduction to Environmental Engineering	9
12-352	Environmental Engineering Lab	3
27-357	Materials Selection	6
12-358	Materials Lab	3
36-220	Engineering Statistics and Quality Control	9
xx-xxx	Elective 3	9
xx-xxx	Elective 4	9

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Senior Year

		Units
	Fall	
12-401	Civil and Environmental Engineering Design	15
12-411	Project Management	9
12-421	Engineering Economics	6
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 5	9

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Spring

xx-xxx	H&SS or CFA Elective	9
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 6	9
xx-xxx	Elective 7	9
xx-xxx	Elective 8	9

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Minimum number of units required for degree: 379

Notes on Electives

1. One elective must be in the basic sciences, either :

03-121	Modern Biology
09-106	Modern Chemistry II or
33-104	Experimental Physics

Substitutions may be made only with the approval of the Department Head.

2. One elective course is restricted to a 600-level Civil Engineering course except 12-648 and 12-690. The Civil Engineering elective is a co-requisite for 12-401.

Specialty Areas in Civil Engineering

Students are encouraged to select a set of civil engineering and technical electives in the junior and senior years that enable them to concentrate in a specialty area if they so desire. Some available options for grouping electives into specialty areas, together with representative course selections, are indicated below.

Infrastructure Systems

12-600	AutoCAD
12-605	Design and Construction
12-611	Project Management for Construction
12-631	Structural Design
12-636	Geotechnical Engineering
12-657	Water Resources Engineering
15-211	Fundamental Data Structures and Algorithms
18-100	Introduction to Electrical and Computer Engineering
21-228	Discrete Mathematics
21-241	Matrix Algebra

Environmental Engineering

12-611	Project Management for Construction
12-657	Water Resources Engineering
12-636	Geotechnical Engineering
12-658	Hydraulic Structures Design
12-651	Air Quality Engineering
06-221	Thermodynamics
06-620	Global Atmospheric Chemistry
09-510	Introduction to Green Chemistry
24-424	Energy and the Environment
48-596	LEED Buildings and Green Design

Structures, Mechanics and Geotechnical Engineering

12-600	Auto CAD
12-605	Design and Construction
12-611	Project Management for Construction
12-635	Structural Analysis
12-631	Structural Design
12-636	Geotechnical Engineering
21-228	Discrete Mathematics
21-241	Matrix Algebra
24-262	Stress Analysis
24-356	Engineering Vibrations
24-401	Engineering Analysis

Double Majors and Minors

Civil engineering students may pursue double majors and minors in a variety of subjects, taking advantage of the free elective courses for other requirements. The college of engineering has added designated minors to promote flexibility and diversity among engineering students. Many CEE undergraduates pursue designated minors in such areas as Engineering Design or Environmental Engineering.

Co-Operative Education Program

Students in civil engineering are encouraged to undertake professional internships during summer breaks. In addition, a formal cooperative internship program is available for either Jan-Aug or May-Dec in the junior year. Students undertaking these 8-month professional internships would ordinarily graduate after an additional semester of study. Program details are available from the Career Center or the Civil and Environmental Engineering office.

Integrated B.S./M.S. Program

Interested undergraduates may plan a course of study that leads to both the BS in Civil Engineering and the MS in Civil and Environmental Engineering. This course of study will ordinarily require ten semesters of study, although advanced placement or other study may reduce this time. Students can apply appropriate units earned as undergraduates for their MS program as long as they are beyond the 373 units required for the BS in Civil Engineering degree. In the tenth semester of study, students should register in graduate status. Interested students should consult their academic advisor or the CEE department office for information about admission to the MS program.

Faculty

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Department of Electrical and Computer Engineering

T.E. (Ed) Schlesinger, Head
Tsuhan Chen, Associate Head
<http://www.ece.cmu.edu/>

The field of electrical and computer engineering encompasses a remarkably diverse and fertile set of technological areas, including analog and digital electronics, computer architecture, computer-aided design and manufacturing of VLSI/ULSI circuits, intelligent robotic systems, computer-based control systems, telecommunications and computer networking, wireless communication systems, signal and information processing and multimedia systems, solid state physics and devices, microelectromechanical systems (MEMS), electromagnetic and electromechanical systems, data storage systems, embedded systems, distributed computing, mobile computing, real-time software, digital signal processing, and optical data processing. The extraordinary advances in the field during the last fifty years have impacted nearly every aspect of human activity. These advances have resulted not only in advanced computer systems but also in consumer products such as "smart" cars, programmable dishwashers and other home appliances, cell phones and mobile computing systems, video games, home security systems, advanced medical systems for imaging, diagnosis, testing and monitoring. Systems and products such as these serve to enhance our quality of life and have also served as the basis for significant economic activity. In short, the field of electrical and computer engineering has become central to society as we know it.

The Department of Electrical and Computer Engineering at Carnegie Mellon is actively engaged in education and research at the forefront of these new technologies. Because of the diverse and broad nature of the field and the significant growth in knowledge in each of its sub areas, it is no longer possible for any single individual to know all aspects of electrical and computer engineering. Nevertheless, it is important that all electrical and computer engineers have a solid knowledge of the fundamentals with sufficient depth and breadth. Society is placing increasing demands on our graduates to try their skills in new contexts. It is also placing increasing value on engineers who can cross traditional boundaries between disciplines, and who can intelligently evaluate the broader consequences of their actions. Our curriculum is designed to produce world-class engineers who can meet these challenges.

Educational Outcomes and Objectives

The B.S. in Electrical and Computer Engineering is a broad and highly flexible ABET-accredited degree program structured to provide students with the smallest set of constraints consistent with a rich and comprehensive view of the profession. Students are encouraged and stimulated to explore multiple areas of theory and application. The Faculty of Electrical and Computer Engineering have established the following objectives for the B. S. in Electrical and Computer Engineering curriculum:

Educational Outcomes

- (a) An ability to apply knowledge of mathematics, science, and engineering.
- (b) An ability to design and conduct experiments, as well as to analyze and interpret data.
- (c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- (d) An ability to function on multi-disciplinary teams.
- (e) An ability to identify, formulate, and solve engineering problems.
- (f) An understanding of professional and ethical responsibility.
- (g) An ability to communicate effectively.
- (h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
- (i) A recognition of the need for, and an ability to engage in, life-long learning.
- (j) A knowledge of contemporary issues.
- (k) An ability to use the techniques, skills, and modern engineering

tools necessary for engineering practice.

Educational Objectives

A. What they know

Our graduates will solve problems based on:

Fundamentals—knowledge of ECE fundamentals;

Breadth—understanding the breadth of areas in ECE;

Depth—substantive command of some specific area(s) of ECE.

B. How they think

Creatively—our graduates will develop creative solutions to problems in current and emerging applications.

Holistically—our graduates will define problems and formulate solutions from a systems perspective.

Strategically—our graduates will anticipate and plan for change and innovation, and engage in lifelong learning.

C. What they do

Initiate—our graduates will stand out for their resourcefulness, ingenuity, and ability to find innovative solutions to problems.

Collaborate—our graduates will work successfully in multidisciplinary teams.

Lead—our graduates will contribute to sustained improvement and development in their organizations, their profession, and society at large.

Curriculum Overview

Minimum number of units required for degree: 379 units.

In addition to the Carnegie Institute of Technology general education and freshman year requirements (141 units), the B.S. in Electrical and Computer Engineering requires Effective Programming in C and Unix (9 units), Physics II (12 units), two math or science electives (18 units), a Probability and Statistics course (9 units), 109 units of Electrical and Computer Engineering coursework, and 2 math co-requisites (21 units). The remaining units needed to reach the 379 required to graduate are Free Electives (60 units).

The Electrical and Computer Engineering coursework is divided into the categories of Core, Breadth, Depth, Coverage, and Capstone Design. The Core consists of five courses (18-100 Introduction to Electrical and Computer Engineering, 18-220 Electronic Devices and Analog Circuits, 18-240 Structure and Design of Digital Systems, 18-243 Introduction to Computer Systems, and 18-290 Signal and Information Processing), and two math co-requisites. These courses provide the fundamental knowledge-base upon which all other electrical and computer engineering courses are built. 18-100 is generally taken during the freshman year, while the remaining courses in the Core are taken starting in the sophomore year. The four core courses are ideally completed by the end of the junior year. (The department strongly recommends that students not take more than two core courses in the same semester.) Although the core courses (and their co-requisites) may be taken in any order, students generally first take the course in their primary area of interest. This gives added flexibility to later course selection in related areas.

Students are also required to complete a seminar course during the fall semester of the sophomore year. This course, 18-200 Emerging Trends in ECE, introduces students to the many areas within ECE and helps them decide which areas are of primary interest to them.

To satisfy the ECE Breadth Requirement, at least one Breadth course must be completed from the lists of Breadth courses on the Web for two of the following five principal areas in ECE (24 units): Applied Physics: Solid State Physics, Electromagnetic Fields and Waves, Magnetics, Optics, etc.; Signals and Systems: Digital Signal Processing, Communication Systems, Control Systems, etc.; Circuits: Analog and Digital Circuits, Integrated Circuit Design, etc.; Computer Hardware: Logic Design, Computer Architecture, Networks, etc.; and Computer Software: Programming, Data Structures, Compilers, Operating Systems, etc.

For the ECE Depth Requirement, one course must be taken that has one of the ECE Breadth courses as a prerequisite. For Coverage any additional ECE course(s) can be taken or approved Computer Science course (see the ECE website for the list of approved Computer Science courses) totaling at least 12 units. Finally, all students are required to take a Capstone Design course. In the Capstone Design courses, numbered 18-5XX, students participate in a semester-long design projects with teams of other students. Students learn project management skills, make oral presentations, write reports, and discuss the broader social and ethical dimensions of ECE. Current Capstone Design courses are listed on the Web.

B.S. Curriculum

Minimum number of units required for degree: 379

For detailed information and regulations of the curriculum along with the degree requirements and the most recent version of the ECE curriculum primer, please refer to the ECE World Wide Web Home Page: <http://www.ece.cmu.edu/>

University Requirement

99-101/99-102/
99-103 Computing @ Carnegie Mellon 3 units

CIT Requirements (see CIT section of the catalog for specifics):

CIT General Education 72 units
2 semesters of calculus 20 units
33-106 Physics for Engineering Students I 12 units
(33-106/107 is the recommended sequence for engineering students, although 33-111/112 or 33-131/132 would also meet the CIT Physics requirement)
1 other introductory engineering course 12 units
(generally taken during the freshman year)

Specific ECE requirements:

1 Introduction to Electrical and Computer Engineering course, taken during the freshman year 12 units
18-100 Introduction to Electrical & Computer Engineering 12 units
1 ECE Seminar, taken during fall of the sophomore year 1 unit
18-200 Emerging Trends in ECE 1 unit
4 ECE core courses, three with math co-requisites 69 units
18-220 Electronic Devices and Analog Circuits 12 units
18-290 Signal and Information Processing 12 units
18-202 Math Foundations of Electrical Engineering (co-requisite to 18-220 and 18-290) 12 units
18-240 Structure and Design of Digital Systems 12 units
21-127 Concepts of Mathematics (co-requisite to 18-240) 9 units
18-243 Introduction to Computer Systems 12 units
2 Breadth Courses from 2 of the 5 Breadth areas within ECE 24 units
1 Depth Course (with a Breadth course as a prerequisite) 12 units
1 Coverage Course (any additional ECE course or Approved CS course as listed on the ECE web site) 12 units
1 Capstone Design Course (a 18-5xx course) 12 units

Other ECE Requirements:

15-100 Introductory Programming (taken during the Freshman year) 10 units
15-123 Effective Programming in C and Unix (prerequisite to 15-213) 9 units
33-107 Physics for Engineering students II 12 units
2 Math/Science electives 18 units

The math/science requirement can be satisfied with any course from The Mellon College of Science or The Department of Statistics except for: 100-level courses in Mathematics or Statistics, and courses designed for non-science or engineering majors, such as 09-103, 09-104, 21-257, 33-124, 36-201, 36-202, 36-207 and 36-208. Although shown in the Fall of the Junior and Senior years, these courses may be taken at any time. Mathematics courses of particular interest to students in ECE are:

21-228 Discrete Mathematics
21-259 Calculus in Three Dimensions
21-260 Differential Equations

1 Probability and Statistics course 9 units

Either 36-217, Probability Theory and Random Processes or 36-220, Engineering Statistics and Quality Control or 36-225, Introduction to Probability and Statistics I. 36-217 (a prerequisite for 18-345, Introduction to Telecommunications Networks and 18-450, Digital Wireless Communications) is recommended for students interested in communications, control, networks, and signal processing. 36-220 is appropriate for students interested in quality control, manufacturing, and statistical methods. The two-course sequence 36-217 and 36-220 (or 36-225 and 36-226) will be of interest for Business Administration double majors.

Free Electives 60 units

Additional courses to be used toward the required 379 units can be any graded course (i.e., not taken as Pass/Fail) taken from one of the academic units on campus (no Physical Education courses, StuCo or ROTC courses may be used toward Free Electives or any graduation requirements).

Total: 379 units

The following table shows a possible roadmap through our broad and flexible curriculum:

Freshman Year		Sophomore Year	
Fall	Spring	Fall	Spring
Introduction to Electrical & Computer Engineering (12)	Introductory Engineering Elective (12)	Emerging Trends in ECE (1)	ECE Core Course (12)
Introductory Programming (10)	Physics for Engineering Students I (12)	ECE Core Course (12)	Concepts of Mathematics/Mathematical Foundations of EE (9/12)
Calculus (10)	Calculus (10)	Mathematical Foundations of EE/Concepts of Mathematics (12/9)	Effective Programming in C and Unix (9)
Writing/Expression Course (9)	General Education Course (9)	Physics for Engineering Students II (12)	General Education Course (9)
Computing @ Carnegie Mellon (3)		General Education Course (9)	Free Elective (9)
Total Units: 44	43	46/43	48/51

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
ECE Core Course (12)	ECE Core Course (12)	ECE Coverage Course I (12)	ECE Capstone Course (12)
ECE Breadth Course 1 (12)	ECE Breadth Course 2 (12)	ECE Depth Course (12)	General Education Course (9)
Probability and Statistics (9)	Math/Science Elective 1 (9)	Math/Science Elective (9)	Free Elective (9)
General Education Course (9)	General Education Course (9)	General Education Course (9)	Free Elective (9)
Free Elective (9)	Free Elective (9)	Free Elective (6/9)	Free Elective (9)
51	51	48/51	48

Notes on the Curriculum

Policy on ECE Coverage Courses with Fewer than 12 Units

The basic curriculum requirements for Breadth, Depth, and Coverage are stated in terms of courses rather than units. The nominal total of 72 units for these categories is determined by assuming that each course is 12 units. In the event that courses with fewer than 12 units are used to satisfy some or all of these requirements, additional courses from the ECE coverage lists must be taken until the total units in ECE courses beyond the core meets or exceeds 72 units. Any ECE coverage course is acceptable, and any excess units may be counted as free elective credit.

QPA Requirement and Overload Policy

An overload is defined as any schedule with more than 54 units in one semester. A student will only be permitted to overload by 12 units if he or she achieved a QPA of at least 3.5 out of 4.0 in the previous semester, or if his or her overall QPA is at least a 3.5.

Pass/Fail policy

No course taken as Pass/Fail may be used in any way toward graduation (including Free Elective credit), unless the course is a required course and may **only** be taken pass/fail (such as 99-101 or 18-200).

Other Graduation Requirements

CIT has the following requirement for graduation. "Students must complete the requirements for their specified degrees with a cumulative quality point average of 2.00 or higher for all courses taken after the freshman year. In addition, a student is expected to achieve a cumulative quality point average of 2.00 in a series of core departmental courses." In ECE, this means that the student must complete 18-100, ECE Core, Breadth, Depth, Coverage, and Design courses with a minimum QPA of 2.0 to graduate.

When more than one possibility exists for meeting a specific requirement (e.g., Breadth), the courses used for calculating the ECE QPA will be chosen so as to maximize the QPA. Similarly, when a course is retaken, the better grade will be used in the computation of the minimum QPA in the above courses.

Other Opportunities in ECE

ECE Cooperative Education Program

The ECE Co-Op is a unique 8-month contiguous extended internship experience in which ECE students with a minimum QPA of 3.0 may opt to participate in. Students typically engage in this option in the spring semester of their junior year, from January through August. A May through December option is also available. Students who engage in this program typically graduate in 4.5 academic years (but still eight semesters).

Eligible students interested in participating should apply to the ECE Undergraduate Office for the program at the close of their sophomore year. Students are required to submit a formal application consisting of a transcript, a resume, and a one-page statement of purpose including an academic plan. Students then work with the Career Center to find a Co-Op position. Once a Co-Op position is found, a Co-Op job description is required from the employer, to be approved by the ECE Undergraduate Office.

While on the Co-Op assignment, the students are participating in a recognized CIT educational program, retaining their full-time student status, akin to our students who study abroad in established exchange programs (such as EPFL) for one or two semesters.

Upon returning to Carnegie Mellon, the students are required to submit for approval the following two documents to the ECE Undergraduate Office: a three to five page technical report of the Co-Op work, and a one page assessment and evaluation of the Co-Op experience.

Students may obtain more detailed information through the department, the Career Center in the University Center, or online at <http://www.ece.cmu.edu/undergrad/>

Integrated M.S./B.S. Degrees Program

The Integrated Master's/Bachelor's program (otherwise known as the IMB program) is an exciting opportunity for students who excel academically to achieve not just a Bachelor's degree in ECE, but also a Master's degree- through our Professional MS degree program-without needing to apply separately. This means no application fee, and no need to take the GRE (Graduate Record Exam) either.

If a student is at least a 2nd semester junior, has completed at least 270 units and has at least a 3.00 QPA, he or she is guaranteed admission into the Professional MS degree in ECE through the IMB program. To be officially admitted, the student must complete the IMB Program form.

Professional MS Degree Requirements:

Please see the ECE web site for the requirements for the Professional MS degree. For students in the ECE IMB program, all requirements for the Professional MS degree are in addition to the requirements for the BS in ECE. No requirements for the MS degree may be used in any way toward the BS degree, including minors, additional majors or dual degrees.

Residency requirements and financial impacts:

Once a student in the IMB program has completed all of the requirements for the BS degree, he or she may become a graduate (Masters) student. To do this, the student's undergraduate degree is certified, and that student officially graduates with the BS degree. Once a student's undergraduate degree has been certified, no more courses may then be applied toward the BS degree. This includes courses toward minors and additional majors, although students pursuing an undergraduate dual degree with another department may still continue to apply additional coursework toward that second degree.

If a student takes more than 8 semesters to complete both the BS and MS degrees, then he or she must be a graduate student for at least one semester before graduating.

To determine the most appropriate time for an undergraduate student to become a graduate student, he or she should consult with Enrollment Services to understand how becoming a graduate student will affect financial aid, and with his or her academic advisor to determine a course schedule. . When a student is a graduate student through the IMB program, the department is able to provide some financial assistance through Teaching Assistantships. Please see the ECE web site for further information regarding this financial assistance.

Faculty

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- CHRISTOS FALOUTSOS, Professor of Computer Science and Electrical and Computer Engineering — Ph.D., University of Toronto; Carnegie Mellon, 1998—.
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- LAWRENCE T. PILEGGI, Tanoto Professor of Electrical and Computer Engineering; — Ph.D., Carnegie Mellon University; Carnegie Mellon 1996—.
- MARKUS PUSCHEL, Associate Research Professor — Ph.D., University of Karlsruhe; Carnegie Mellon, 1999—.
- RAGUNATHAN RAJKUMAR, Professor of Electrical and Computer Engineering; Co-Director - GM, CMCRL Director, Real-Time and Multimedia Systems Laboratory — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1992—.
- MIKE REITER, Adjunct Professor of Electrical and Computer Engineering and Computer Science — Ph.D., Cornell University; Carnegie Mellon, 2001—.
- DAVID RICKETTS, Assistant Professor of Electrical and Computer Engineering — Ph.D. Harvard University, 2006—.
- GUSTAVO ROHDE, Emeritus Professor of Electrical and Computer Engineering — Ph.D., University of Maryland, 2006—.
- RONALD ROHRER, Emeritus Professor of Electrical and Computer Engineering — Ph.D., University of California, Berkeley, 2008—.
- ROB A. RUTENBAR, Stephen J. Jatras Professor of Electrical and Computer Engineering and Computer Science; Director, MARCO Focus Center for Circuit and System Solutions — Ph.D., University of Michigan; Carnegie Mellon, 1984—.
- MAHADEV SATYANARAYANAN, Carnegie Professor of Computer Science and Electrical and Computer Engineering — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1983—.
- MARIOS SAVVIDES, Research Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2005—.
- TUVIAH E. SCHLESINGER, Professor of Electrical and Computer Engineering; Head, Department of Electrical and Computer Engineering — Ph.D., California Institute of Technology; Carnegie Mellon, 1985—.
- SRINI SESHAN, Associate Professor of Computer Science and Electrical and Computer Engineering — Ph.D., University of California at Berkeley; Carnegie Mellon 2000—.
- DANIEL P. SIEWIOREK, Buhl University Professor of Electrical and Computer Engineering and Computer Science; Director, Human Computer Interaction Institute — Ph.D., Stanford University; Carnegie Mellon, 1972—.
- BRUNO SINOPOLI, Assistant Professor of Electrical and Computer Engineering — University of California, Berkeley, 2007—.
- MARVIN A. SIRBU, Professor of Engineering and Public Policy, Tepper School of Business and Electrical and Computer Engineering — D.Sc., Massachusetts Institute of Technology; Carnegie Mellon, 1985—.
- METIN SITTI, Associate Professor of Mechanical Engineering and Electrical, Computer Engineering and Robotics Institute — Ph.D., University of Toledo; Carnegie Mellon, 2002—.
- ASIM SMAILAGIC, Research Professor of ICES and Electrical and Computer Engineering; Director, LINC — Ph.D., University of Sarajevo and University of Edinburgh; Carnegie Mellon, 1992—.
- DAWN SONG, Adjunct Professor of Electrical and Computer Engineering and Computer Science — Ph.D. University of California at Berkeley; Carnegie Mellon, 2002—.
- DANIEL D. STANCIL, Professor of Electrical and Computer Engineering; Director, Center for Wireless and Broadband Networking — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1986—.
- PETER STEENKISTE, Professor of Electrical and Computer Engineering and Computer Science — Ph.D., Stanford University; Carnegie Mellon, 1987—.
- RICHARD M. STERN, JR., Professor of Electrical and Computer Engineering, Computer Science, and Biomedical Engineering — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1977—.
- ANDRZEJ J. STROJWAS, Keithley Professor of Electrical and Computer Engineering — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1983—.
- THOMAS SULLIVAN, Associate Teaching Professor, Electrical and Computer Engineering — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1996—.
- SAROSH N. TALUKDAR, Emeritus Professor of Electrical and Computer Engineering — Ph.D., Purdue University; Carnegie Mellon, 1974—.
- ALFRED A. THIELE, Distinguished Scholar — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1981—.
- DONALD E. THOMAS, JR., Professor of Electrical and Computer Engineering — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1977—.
- OZAN TONGUZ, Professor of Electrical and Computer Engineering — Ph.D., Rutgers University; Carnegie Mellon, 2000—.
- ELIAS TOWE, Professor of Electrical and Computer Engineering, Grobstein Memorial Professor of Materials Science and Engineering; Director, CNXT — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2001—.
- PAULO VERISSIMO, Adjunct Professor of Electrical and Computer Engineering and Professor of University of Lisboa, Portugal — Ph.D. IST of the Technical University of Lisboa, 2008—.
- ANTHONY WASSERMAN, Professor of Software Engineering Practice — Carnegie Mellon West, ECE; Director, Software Management Program, Executive Director, Center for Open Source Investigation — Carnegie Mellon West — Ph.D., University of Wisconsin, Madison, 2008—.
- ROBERT WHITE, Emeritus, University Professor Emeritus of Electrical and Computer Engineering and Engineering and Public Policy — Ph.D., Stanford University; Carnegie Mellon, 1993—.
- JEANNETTE WING, President's Professor of Computer Science; Professor of Electrical and Computer Engineering — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1985—.
- TINA WONG, Systems Scientist; CyLab, INI and ECE — Ph.D., University of California at Berkeley; Carnegie Mellon, 2005—.
- PATRICK YUE, Adjunct Professor of Electrical and Computer Engineering — Ph.D., Stanford University; Carnegie Mellon, 2003—.
- ERIK YDSTIE, Professor of Chemical Engineering and Electrical and Computer Engineering — Ph.D., Imperial College, London, 1992—.
- HUI ZHANG, Professor of Computer Science and Electrical and Computer Engineering — Ph.D., University of California at Berkeley; Carnegie Mellon 1995—.
- JIAN-GANG ZHU, ABB Professor of Electrical and Computer Engineering; Director, DSSC.; Professor of Materials Science and Engineering and Physics — Ph.D., University of California, San Diego; Carnegie Mellon, 1997—.

Department of Engineering and Public Policy

M. Granger Morgan, Head
Mark Kieler, Assistant Department Head
Office: Baker Hall 129

Mission Statement

The Department of Engineering and Public Policy (EPP) is a unique engineering department, whose overall objective is to enhance undergraduate engineering education with the perspectives and skills that enable the engineer to understand and work at the interface between technology and society. Society is largely responsible for setting the goals and framing the problems that engineers work on. However, technologies designed by engineers profoundly change the societies in which they operate. Technology has enabled a healthier, richer and more productive society. At the same time, technology has contributed to the creation of many of the more serious problems our society faces.

Technology can help us build a happier, freer, and more fulfilling life, while maintaining risks and undesirable impacts at acceptable levels. But that does not happen automatically. It takes careful hard work by people who understand both technology and the society in which they live. In order to do their jobs responsibly and well in today's world, engineers must develop an understanding of the interface between technology and society and a command of the skills necessary to work at that interface. The undergraduate degree programs of the Department of Engineering and Public Policy (EPP) have been designed to allow engineering students at Carnegie Mellon University to add this important dimension to their traditional engineering education. EPP double major graduates, for the most part, will enter traditional engineering careers ...and in doing so will carry with them a set of insights and skills that will help them to better deal with issues in technology and policy, and better exercise their ethical and social obligations as practicing professionals.

Educational Outcomes: Double Major Knowledge and Skills Development

Through required courses, carefully selected technical and non-technical electives, and project activities, double major students in Engineering and Public Policy develop the knowledge and skills needed to understand and address the broader social context of technology during the course of their future careers as practicing engineers. Specifically they develop:

- An understanding of ideas and analytical tools in economics, decision science, and other social sciences through several required courses and a group of "social analysis electives;"
- A knowledge of probability and statistics beyond that acquired by many engineering single majors;
- An understanding of how technical and social issues interact and affect each other through a set of required "EPP technical electives" (these courses are also available to other CIT students who wish to broaden their technical education).
- An appreciation of, and ability to deal with, ethical issues posed by technology and technical systems through case studies and discussion in the EPP Sophomore Seminar. Additionally, students may choose EPP technical and social analysis electives that cover ethics in disciplinary, philosophical, societal, and technical contexts.
- Hands on experience in integrating their technical and social analytical skills by addressing current, open-ended technology and public policy problems in two group project courses. These courses also require students to work in interdisciplinary groups, and they enhance communications skills through group processes and formal presentations.
- An understanding of how decision-makers in governments and other institutions can effectively use technical and scientific information when devising or evaluating public policy.

Double Major Objectives: Advantages in Career Paths

By design, most graduates from Engineering and Public Policy pursue traditional technical career paths. However, the double major provides students with additional insights and abilities including:

- Display an understanding that engineering is not practiced in isolation. Technical products and systems are shaped, conditioned and evaluated by society while at the same time technology shapes the social world.
- Recognize situations and know how to seek advanced assistance where one's work may have effects in areas beyond the traditional expertise of engineers: These areas include health and safety; environmental and economic regulation; and impacts of technological innovation.
- Display an appreciation of the difference between the effects and attributes of engineering a single device or small system, versus engineering for mass consumption or for large technological systems.
- Use, or seek help in using, tools and methods to approach complex decision problems that engineers often must face, including issues beyond the design of products and processes.
- Consider career paths more diverse than those traditionally associated with engineering or other technical careers.
- Demonstrate an ability to integrate conventional technical analysis with behavioral and other social issues, where the engineer is a participant in teams composed of many disciplines.

Overview

The department offers double-major B.S. degree programs with each of the five traditional engineering departments in the engineering college, as well as with the School of Computer Science. These joint degree programs, which have been offered since 1971, are now chosen by about 10 percent of all undergraduate engineering students at Carnegie Mellon. Typically, they only require the unit equivalent of less than one added course. The engineering double-major programs lead to fully accredited engineering degrees that prepare students for traditional engineering careers. EPP double-major engineers are not educated to be a different kind of engineer. Rather their education is intended to enable them to be better, more socially responsible engineers in the traditional engineering fields. The department also offers a minor in Technology and Policy for non-engineering majors.

All of the undergraduate double major programs in EPP combine the strong foundation in mathematics and physical sciences, and the development of engineering skills in the specific engineering field, with a rigorous preparation in the analysis of social and political problems. The curricula include subject matter which is not part of traditional engineering or social science curricula, but which contains elements of each. This is accomplished by Engineering and Public Policy technical elective courses, social analysis courses, and through participation by each student in at least two interdisciplinary problem-solving projects. Problem areas for these projects are chosen from local, state, and national situations and include such topics as industrial automation and robotics, environmental control, telecommunication and computer technologies, product safety, and energy systems. Engineering and Public Policy students take courses in engineering and science offered by the Carnegie Institute of Technology and the Mellon College of Science, and the social science, humanities, and industrial administration courses offered in the College of Humanities and Social Sciences and the Tepper School's undergraduate business program. There is also significant interaction between EPP students and the Environmental Institute, the H. John Heinz III School of Public Policy and Management, and the Department of Social and Decision Sciences.

All undergraduates interested in the programs of the department complete their freshman year before declaring their major. Students planning to be double majors with chemical, mechanical, or materials sciences and engineering are especially advised to check the double-major curriculum before selecting their freshman elective courses so as to avoid possible overloads later in the program.

Some of the designated minors such as the Environmental Engineering minor are also compatible with the EPP double major without overload, if the program of study is carefully planned beginning in the freshman year. Additional non-CIT minors such as in Business Administration or an H&SS discipline may not be possible without overloads. If you are interested in exploring these options, please contact the EPP undergraduate advisors early.

The majority of the double-major graduates in Engineering and Public Policy pursue conventional engineering careers, using the additional dimension in their background to improve the quality, sensitivity, and social responsiveness of their work, and the work of their colleagues. Many who begin in conventional engineering careers later migrate into positions with responsibilities which make special use of their EPP education. A number of graduates elect careers with local, state, or national government or with policy research and consulting firms. Some choose to continue their formal education, doing graduate work in an engineering discipline, in the social sciences, law, or in an interdisciplinary program.

Current faculty advisors of the program are the following:

For Chemical Engineering/Engineering and Public Policy majors: Mark Kieler

For Civil Engineering/EPP majors: Cliff I. Davidson, Mitchell J. Small, Scott Matthews, Peter Adams

For Computer Science/EPP majors: Mark Kieler

For Electrical and Computer Engineering/EPP majors: Jon Peha, Marvin A. Sirbu, Mark Kieler, Marija Ilic, Adrian Perrig

For Mechanical Engineering/EPP majors: Edward S. Rubin, Allen Robinson

For Materials Science and Engineering/ EPP majors: Mark Kieler

For EPP-Heinz School Accelerated Masters program students: Mark Kieler

Designated Minors are possible with an EPP double major. Students should see their advisor early to plan for these.

Students can also obtain general academic advice and guidance from Mark Kieler, the undergraduate assistant department head of EPP.

Credit-unit overloads of between one and six units are also involved. To ease these overloads, some students occasionally elect a minimum of summer work. Course and credit-unit requirements for the single-major and double-major degrees are listed on the next page.

Double-Major Curricula

Bachelor of Science in an Engineering Specialty and Engineering and Public Policy, or Computer Science and Engineering and Public Policy

The EPP double-major curricula allow the student the option of a number of non-traditional career paths, and at the same time preserve the option of a traditional technical career. Following the sample curricula below, the student simultaneously satisfies all requirements for the undergraduate degree in a traditional engineering department or computer science, and all requirements for the undergraduate degree in Engineering and Public Policy. With early planning, some of the designated minors are also possible without overload.

This degree program has the attractive feature of allowing technical students to keep a number of options open after they graduate. Students graduating with a double-major degree have found a range of job possibilities, from traditional engineering jobs in industrial organizations to assignments in consulting firms and positions in local and national government. Students have also entered graduate schools of engineering, business, urban management, and law.

Specific degree requirements for the double major program vary with department. However, with the exception of a three-unit

seminar course, the double-major program requires the same number of courses for completion as the corresponding single-major departmental degree programs. However, as the curricula on the following pages illustrate, there are substantial differences between elective course requirements for the double-major and single-major students.

Field	Single Major	Double Major with EPP
Chemical Engineering	386	392
Civil Engineering	379	388
Computer Science	361	370
Electrical & Computer Engineering	379	382
Materials Science and Engineering	379	385
Mechanical Engineering	380	387

Course requirements for each double-major degree are listed below. By completing these requirements, a student simultaneously completes all requirements for each departmental degree. Students who feel that they may be interested in an EPP double major program are advised to check with the appropriate faculty advisor or with Mark Kieler in the EPP Department about the optimal selection of courses. By planning the four-year curriculum in the freshman year, the student can be sure to get the maximum flexibility, and the maximum advantage from any advanced placement credits he or she may have.

Note on EPP double major requirements

This note is intended to clarify the major substitutions that occur in the single major curriculum when it is fashioned into an EPP double major curriculum.

Freshman Electives: An EPP major is not required to take the Introduction to EPP course although taking it may be a way to find out the kind of questions and issues studied in EPP. All EPP students are required to take 19-102 EPP Sophomore Seminar in the fall of their sophomore year. In order to avoid overloads later in the curriculum, students wishing to pursue the EPP double major should complete the freshman and sophomore electives required by the student's other traditional technical department. These requirements are listed in the Undergraduate Catalog for the various departments.

For CIT students, the introductory engineering course in the major and a second introductory course must be completed. Students wishing to pursue EPP are also advised to complete the humanistic studies and Writing/ Expression requirements listed in the section on General Education program for CIT Students. However, as explained below, the other distribution requirements - cognition and institutions, depth sequence and other general education elective categories are replaced by the policy components of the double major curriculum as reflected in the social analysis electives described later. All EPP students are required to take 73-100 Principles of Economics and should complete this as early as possible.

A MSE/EPP double major may choose the Industrial Internship Option (IIO) which is a MSE program in cooperative education. Just as in the MSE single major IIO option, the MSE/EPP (IIO) option provides the students with an opportunity to supplement the academic program with relevant work experience in metallurgy and materials science as well as in the public policy area.

Under the IIO option the student enhances classroom learning by alternating one-semester work periods in industry with on-campus semesters. Interested students should read the relevant parts of the MSE section carefully. Note that, while the course requirements are the same, the program requires academic or internship work in each summer following the sophomore year, and at least one extra semester to complete the needed coursework.

EPP Core courses

The EPP double major curriculum consists of two sets of core courses: one set for the disciplinary major (ChE, Civ E, CS, ECE, MEG, MSE) and the second set for the interdisciplinary EPP major. The student is referred to the relevant sections of this catalog for the core courses in the disciplinary major. The EPP core contains the sophomore seminar, two EPP project courses, two semesters of a probability and statistics sequence, an introductory economics and a decision science course. The EPP core consists of the following courses:

19-102	EPP Sophomore Seminar
19-451	EPP Project I
19-452	EPP Project II
73-100	Principles of Economics
88-xxx/19-xxx	Decision Analysis (see below)
36-xxx	Probability and Statistics (2 courses, see below)
xx-xxx	4 EPP Technical Electives
xx-xxx	4 EPP Social Analysis Electives

These requirements are described in more detail below.

The above EPP Core Courses in general replace technical and general education requirements, seminars, and free electives of the single major.

Technical Course Requirements

Probability and Statistics Sequence

In today's world, knowledge of probability and statistics are critical in understanding how technological systems operate. The EPP double major requires that students take a 2 course sequence in probability and statistics. If the student's primary major has a statistics requirement as well, that course may count towards meeting one of the two course requirement. The courses should be selected from the following list:

36-217 Probability Theory and Random Processes
36-220 Engineering Statistics and Quality Control
36-310 Fundamentals of Statistical Modeling

All students generally take 36-220 and then one other statistics course.

- ChE/EPP majors take 36-220 in place of a technical elective and the second course in place of a free elective.
- Civ E/EPP majors have 36-220 in their single major curriculum, and take the second course as a free elective.
- CS/EPP majors should take 36-217 as part of their single major curriculum, and take the second course as a free elective.
- ECE/EPP majors must take 36-220 or 36-217 in their single major curriculum, and take the second course as a free elective. Note that 36-217 is the preferred option for students planning to take the communications course.
- ME /EPP majors take 36-220 in place of a technical elective and the second course in place of a free elective.
- MSE/EPP majors take 36-220 as part of their single major curriculum and the second course in place of a technical elective.

EPP Technical Electives

EPP Technical Electives include courses in CIT, MCS, or SCS that generally belong to two categories: courses which synthesize engineering analysis and social analysis perspectives and apply them to problems with substantial societal technological components; and courses which teach methods or background vital to classes of important problems at the technology-society interface. Specific areas of interest for these courses are (1) energy, resources, and the environment, (2) risk assessment, (3) forensic engineering, (4) urban engineering, (5) information and communication technology, (6) product engineering and design, and (7) robotics. Courses in other topic areas may also be included as determined from year to year.

Each student elects four of these courses. A list of qualifying Technical Electives is assembled each semester.

The following categories of courses count as Technical Electives:

- 19-xxx EPP departmental courses are considered Technical Electives. Exceptions to this rule will be identified when the courses are offered.
- Courses in engineering, mathematics, or science that have direct policy analysis applications are considered Technical

Electives. Examples include mathematics courses related to optimization, estimation, and related topics.

- Courses on substantive technical issues of relevance to policy analysis are considered Technical Electives. While most technical domain knowledge has some application to policy, qualifying courses are those with information that is essential to deal with policy domains in which EPP students and faculty are actively engaged. Examples include courses in environmental engineering, electric power and energy systems, biological processes relevant to health and safety risks, climate change, and processes of engineering design.
- Double-counted courses already in a double major core curriculum qualify as Technical Electives. Because several traditional majors cannot accommodate four EPP Technical Electives without overload, EPP counts selected courses in those departments as Technical Electives even though the courses may not exactly meet the above selection criteria. In some cases, a course is modified slightly for content deemed relevant to EPP, and EPP students register under a separate number for the course.

Students should work with their advisors to define areas of concentration or a selection of breadth courses for the Technical Electives.

All double majors must complete the four EPP technical electives with the following special cases:

- ChE/EPP students count the following ChE core courses as 2 EPP Technical Electives and hence take only two more EPP Technical Electives:

06-421	Chemical Process Systems Design (12 units)
06-461	Process Design Project (6 units)
06-462	Economics and Optimization (6 units)
- Civ E/EPP students count two core mini courses, 12-411 Engineering Economics and 27-357 Introduction to Materials Selection, as one EPP Technical Elective, and take only three more EPP Technical Electives.
- ME/EPP students count 27-401 Design II: Conceptualization and Realization as an EPP Technical Elective, and take only three more EPP Technical Electives.
- MSE/EPP students count 27-401 and 402 in place of one EPP technical elective and hence take only three more EPP Technical Electives.

If you are pursuing a designated minor as well, the EPP Technical Electives must be chosen from among the courses for the designated minor which are also EPP Technical Electives to prevent unnecessary overloading.

Social Analysis Requirements

Decision Analysis and Economics Requirements

For analysis of technical and policy problems in the department, it is important to understand how decisions are made and how economic conditions affect alternatives. Students are required to complete the following economics course:

73-100 Principles of Economics

Students should complete 73-100 as early as possible, preferably during their freshman year.

Students are also required to complete one decision analysis course from the following list:

88-223	Decision Analysis and Decision Support Systems
88-302	Behavioral Decision Making
19-426	Environmental Decision Making

88-223 and 88-302 have a statistics course prerequisite.

Social Analysis Electives

In addition to traditional engineering skills, EPP double majors are expected to acquire social science skills that prepare them to address the complicated problems which confront engineers in both the public and private sector. Courses that fulfill the Social Analysis Elective category fall into a number of topic areas, such as (1) economics, (2) interpersonal processes, (3) organizations, (4) ethics, (5) political analysis, (6) urban analysis, (7) technology and society, (8) international peace and security, (9) policy analysis, and (10) the role of computers in institutions. Courses in other topic areas may also be included as determined from year to year. Students are permitted to choose their electives concentrated in one

topic area, or they can select a breadth of courses in different areas.

The Social Analysis electives include:

88-xxx	All courses in Social and Decision Sciences
73-xxx	All economics courses in the Undergraduate Economics Program jointly administered with the Tepper School of Business.

IMPORTANT NOTE: Occasionally, these departments may offer a course which we deem unsuitable as a social analysis elective. We will note these courses in the advising packets associated with a particular semester. Students should check their advising packets for unallowable courses.

In addition, in any given semester, offerings may include selected courses in the Department of Architecture, the Department of Design, the Department of History, the Department of Philosophy, the Heinz School of Public Policy, and the Tepper School of Business that qualify as Social Analysis Electives. Other departments may also offer courses that qualify in some semesters; students should consult the EPP list of Social Analysis electives when it is distributed for each specific semester.

Students should work with their advisors to define specific areas of concentration or to identify a selection of breadth courses. Note that students pursuing an EPP double major will use their Social Analysis electives to replace three categories of CIT electives: the H&SS/CFA Depth Sequence, the Non-technical Electives, and the Free Electives.

The Social Analysis requirements provide an effective "depth sequence" for EPP students. Hence they are not required to complete the CIT depth sequences. However, they must complete the Writing and Cultural Analysis requirements.

Special Feature: Interdisciplinary Problem-Solving Projects

One of the most interesting and unique features of the Department of Engineering and Public Policy is the problem-solving project courses which are designed to provide a student with real-world experiences. Each student participates in two technology/policy projects (generally, one each in the junior and senior years) which deal with research and development of recommendations for solving actual and critical problems currently affecting society. The students, faculty, and graduate student managers for the project are drawn from EPP, the Heinz School, and H&SS, and hence bring different areas of expertise to the structuring and solution of the problem.

The topics for EPP projects are drawn from diverse areas such as environmental systems and resources, public transportation, urban engineering problems, energy and fuel utilization, the interaction of law and technology, strategic materials and vulnerability of supply, technical issues in national security, and problems in automation, robotics and communication technology.

Although a different topic is chosen for each project, every project has the same basic characteristics:

1. The problem selected for study is associated with a public policy problem and is constrained by technology, politics, and economics.
2. A client is defined to focus the framework within which the project is worked. Often, the client agency or institution interacts closely with the students in the project.
3. A set of external experts acts as a client for the project and composes a review panel which critiques class efforts during the semester.
4. Class organization is aimed at putting together a workable set of alternatives to the problem. Typically, groups of four to eight students investigate specified aspects of the problem; group efforts are coordinated by student managers and faculty advisors; and objectives and personnel are reassigned during the semester. Three formal oral reports are given before the review panel during the semester; a written report is also submitted at the end of the semester.
5. Problem areas for the projects are abstracted from local, state and national situations. Examples of topics and clients of projects undertaken by EPP students are listed below.
 - "Safety with Fuel Efficiency: Alternatives to CAFE" (1991)—public;
 - "Design Issues in Waste Avoidance" (1991) - Pennsylvania Department of Environmental Resources;

- "Aral Sea Regional Ecological Crisis" (1992) - Senator Albert Gore of Tennessee;
- "Airbags: Help or Harm?" (1997) — public;
- "Food Irradiation" (1998) — public;
- "Transition to a Hydrogen-Based Energy System: The Next Ten Years" (2000) — public;
- "Event Data Recorders: Technical, Economic and Legal Issues" (2003) — public;
- "Hybrids and Diesels: Forecasting Future Impacts" (2005) — public;
- "U.S. Oil Refineries: Spatial Dimensions of Economics, Regulatory Policy and Environmental Justice" (2005) — public;
- "The Impact of Spyware" (2005) — public;
- "Unmanned Aircraft in the National Airspace System" (2007) — public;
- "Policy Dimensions of New Space Technologies" (2008) — public.

Each academic year at graduation, the best undergraduate project from the previous year is awarded the Stephen O. Lee Undergraduate Policy Project Award. All student participants are recognized.

Fifth Year M.S. program in Engineering and Public Policy

Juniors affiliated with the department may apply for the fifth year masters program that will lead to the additional degree of Master of Science in Engineering and Public Policy. Interested students must have a minimum 3.0 QPA and should contact their advisor for details on the application process.

Following are the additional requirements for the MS degree. Note that no course taken may count for both a BS in CIT and the MS degree (students minoring in Technology and Policy from a non-CIT department should consult with their home college about double counting issues). Note that successful completion of the MS degree requires 96 units of coursework and research.

Requirements for Fifth year M.S. in Engineering and Public Policy

I. Type A [Technical] Courses		30 units
12-704	Estimation Methods	12 units
xx-xxx	Technical Elective 1 (400-level or higher)	9 units
xx-xxx	Technical Elective 2 (400-level or higher)	9 units
II. Type B [Social Analysis] Courses		24 units
90-908	Microeconomics	12 units
xx-xxx	Social Analysis (Graduate Level)	12 units
III. Type C [EPP Core] Courses		36 units*
19-701	Theory and Practice of Policy Analysis	12 units**
AND		
19-702	Quantitative Methods for Policy Analysis	
Or any two of the following 6 unit courses:		
19-703	Survey Design and Analysis	
19-704	Applied Data Analysis	
19-705	Workshop in Applied Policy Analysis	12 units**
AND		
19-752	EPP Project Management	12 units
IV.	Project Research	18 units

Total units required for degree 96 units

* 12 units of these courses will be taken (and counted) as an undergraduate Technical Elective, and will not count toward the 96 unit MS degree.

** The primary concern for scheduling and completing this integrated program is completing the 2-year sequence of core EPP graduate courses (19-701 in addition to 19-702, or 2 courses from 19-703, 19-704, or 19-705). These courses are individually taught every other academic year. The student should ensure that they schedule the courses offered in their senior year, followed by the remainder in their fifth year

Students may elect to begin the Project Research component after their fourth year.

Minor in Technology and Policy

The department also offers a minor in Technology and Policy to non-CIT majors. This minor allows non-technical students to sample the EPP requirements and develop exposure and awareness to issues at the interface of science, technology, and society. Details of this program are provided in the discussion of CIT minors

Bachelor of Science in Engineering and Public Policy and Master of Science in Public Management and Policy

Highly motivated and talented students can earn the EPP double major bachelor's degree, and a master's degree in the H. John Heinz School of Public Policy and Management in a five-year course of study. Students interested in the combined degree program should enroll in a standard double-major program in an engineering specialty and EPP. During the third year of study, the student applies to the Heinz School for admission to the master's program; an academic record of B average or better is normally a prerequisite for admittance.

The five-year course of study is possible because of specific course load overlaps between the EPP and Heinz School programs: (1) some social analysis requirements in EPP, usually four semester courses, can be satisfied with Heinz School common core courses in economics, and social science; (2) at least one project course is common and applicable to both curriculums; (3) at least one additional EPP technical elective, engineering option or project course will be accepted for Heinz School credit following the usual request to the master's committee.

Students desiring this option should seek faculty advice and counsel in their freshman or sophomore year so that a curriculum satisfying all the degree requirements can be ensured. Contact Mark Kieler (Assistant Head, EPP) for more information. For general information on Heinz 3-1-1 programs please contact the Heinz school or refer to their website.

**Chemical Engineering
Single Major**

Sophomore Year		Units
	Fall	
21-259	Calculus in Three-Dimensions	9
06-221	Thermodynamics	9
06-222	Sophomore Chemical Engineering Seminar	1
09-106	Modern Chemistry II	10
15-100/ 33-107	Introductory Intermediate Programming / Physics for Engineering Students II	10-12
xx-xxx	General Education Course	9
		48-50
	Spring	
06-261	Fluid Mechanics	9
06-262	Mathematical Methods of Chemical Engineering	12
09-221	Lab 1: Introduction to Chemical Analysis	12
33-107/ 15-100	Physics for Engineering Students II / Introductory Intermediate Programming	12-10
xx-xxx	General Education Course	9
		54-52
Junior Year		Units
	Fall	
06-321	Chemical Engineering Thermodynamics	9
06-323	Heat and Mass Transfer	9
06-322	Junior Chemical Engineering Seminar	2
09-217	Organic Chemistry I	9
09-347	Advanced Physical Chemistry	12
xx-xxx	General Education Course	9
		50
	Spring	
06-361	Unit Operations of Chemical Engineering	9
06-362	Chemical Engineering Process Control	9
06-363	Transport Processes Laboratory	6
03-232	Biochemistry	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9
		51
Senior Year		Units
	Fall	
06-421	Chemical Process Systems Design	12
06-422	Chemical Reaction Engineering	9
06-423	Unit Operations Laboratory	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9
		48
	Spring	
06-461	Process Design Project	6
06-462	Economics & Optimization	6
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9
		48

Minimum number of units required for degree: 386

**Chemical Engineering with an Additional Major in
Engineering and Public Policy**

Sophomore Year		Units
	Fall	
21-259	Same	9
06-221	Same	9
09-106	Same	10
15-100/ 33-107	Same	10-12
73-100	Principles of Economics	9
19-102	EPP Sophomore Seminar	3
		50-52
	Spring	
06-261	Same	9
06-262	Same	12
09-221	Same	12
33-107/ 15-100	Same	12-10
xx-xxx	EPP Social Analysis Elective*	9
		54-52
Junior Year		Units
	Fall	
06-321	Same	9
06-323	Same	9
09-217	Same	9
09-347	Same	12
xx-xxx	EPP Social Analysis Elective*	9
		48
	Spring	
06-361	Same	9
06-362	Same	9
09-363	Same	6
36-220	Engineering Stats and Quality Control	9
19-451	EPP Project	12
xx-xxx	EPP Social Analysis Elective*	9
		54
Senior Year		Units
	Fall	
06-421	Same	12
06-422	Same	9
06-423	Same	9
19-452	EPP Project	12
xx-xxx	EPP Social Analysis Elective*	9
		51
	Spring	
06-461	Same	6
06-462	Same	6
xx-xxx	EPP Technical Elective	9
xx-xxx	EPP Technical Elective	9
36-310	Fundamentals of Statistical Modeling	9
xx-xxx	EPP Social Analysis Elective*	9
		48

Minimum number of units required for degree: 392

* One of these must be taken from the following list:
 88-302 Behavioral Decision Making
 88-223 Decision Analysis and Decision Support Systems

Civil Engineering
Single Major

Sophomore Year		Units
	Fall	
12-212	Statics	9
15-100	Introductory/Intermediate Programming	10
21-259	Calculus in Three Dimensions	9
09-101	Intro to Experimental Chemistry	3
09-105	Modern Chemistry I	10
xx-xxx	H&SS Elective	9

50

Spring		Units
12-231	Solid Mechanics	9
12-232	Solid Mechanics Lab	3
12-271	Intro Computer Apps in Civil & Environmental Engr	9
21-260	Differential Equations	9
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 1	9

48

Junior Year		Units
	Fall	
12-301	Civil and Environmental Engineering Projects	9
12-335	Soil Mechanics	9
12-336	Soil Mechanics Lab	3
12-355	Fluid Mechanics	9
12-356	Fluid Mechanics Lab	3
xx-xxx	Elective 2	9
xx-xxx	H&SS or CFA Elective	9

51

Spring		Units
12-351	Introduction to Environmental Engineering	9
12-352	Environmental Engineering Lab	3
27-357	Materials Selection	6
12-358	Materials Lab	3
36-220	Engineering Statistics and Quality Control	9
xx-xxx	Elective 3	9
xx-xxx	Elective 4	9

48

Senior Year		Units
	Fall	
12-401	Civil and Environmental Engineering Design	15
12-421	Engineering Economics	6
xx-xxx	H&SS or CFA Elective	9
12-411	Project Management	9
12-xxx	Elective 5	9

48

Spring		Units
xx-xxx	H&SS or CFA Elective	9
xx-xxx	H&SS or CFA Elective	9
xx-xxx	Elective 6	9
xx-xxx	Elective 7	9
xx-xxx	Elective 8	9

45

Minimum number of units required for degree: 379

Civil Engineering with an Additional Major in Engineering
and Public Policy

Sophomore Year		Units
	Fall	
12-212	Same	9
15-100	Same	10
21-259	Same	9
09-101	Same	3
09-105	Same	10
73-100	Principles of Economics	9
19-102	EPP Sophomore Seminar	3

53

Spring		Units
12-231	Same	9
12-232	Same	3
12-271	Same	9
21-260	Same	10
xx-xxx	EPP Social Analysis Elective	9
xx-xxx	Basic Science Elective (09-106, 33-104, or 03-121)	9

48

Junior Year		Units
	Fall	
12-301	Same	9
12-335	Same	9
12-336	Same	3
27-355	Same	6
12-356	Same	3
xx-xxx	EPP Social Analysis Elective*	9
xx-xxx	EPP Social Analysis Elective*	9

51

Spring		Units
12-351	Same	9
12-352	Same	3
27-357	Same	6
12-358	Same	3
36-220	same	9
xx-xxx	EPP Social Analysis Elective*	9
19-451	EPP Project	12

51

Senior Year		Units
	Fall	
12-401	Same	15
12-421	Same	6
12-xxx	Restricted Elective Co-Requisite for 12-401	9
12-411	Same	9
19-452	EPP Project	12

51

Spring		Units
xx-xxx	EPP Social Analysis Elective	9
36-xxx	2 nd EPP Stats Course (36-217 or 36-310)	9
xx-xxx	EPP Technical Elective	9
xx-xxx	EPP Technical Elective	9
xx-xxx	EPP Technical Elective	9

45

Minimum number of units required for degree: 388

* One of these must be taken from the following list:
88-302 Behavioral Decision Making
88-223 Decision Analysis and Decision Support Systems

Computer Science
Single Major

Sophomore Year		Units
	Fall	
15-123	Effective Programming in C and Unix	9
15-212	Principles of Programming	12
21-241	Matrix Algebra	9
xx-xxx	Science/Engineering Course	9
xx-xxx	Humanities and Arts Elective	9

		48
	Spring	
15-213	Introduction to Computer Systems	12
15-221	Technical Communications for Computer Scientists	9
15-xxx	Computer Science Elective	9
xx-xxx	Engineering / Science Course	9
xx-xxx	Minor Requirement / Free Elective	9

Junior Year		Units
	Fall	
15-451	Algorithm Design and Analysis	9
15-xxx	Computer Science Elective	9
xx-xxx	Probability Course	9
xx-xxx	Minor Requirement / Free Elective	9
xx-xxx	Humanities and Arts Elective	9

		45
	Spring	
15-xxx	Computer Science Elective	12
15-xxx	Computer Science Elective	9
xx-xxx	Minor Requirement / Free Elective	9
xx-xxx	Humanities and Arts Elective	9

Senior Year		Units
	Fall	
15-xxx	Computer Science Elective	12
xx-xxx	Minor Requirement / Free Elective	9
xx-xxx	Humanities and Arts Elective	9
xx-xxx	Minor Requirement / Free Elective	9

		39
	Spring	
15-xxx	Computer Science Elective	9
xx-xxx	Minor Requirement / Free Elective	9
xx-xxx	Minor Requirement / Free Elective	9
xx-xxx	Humanities and Arts Elective	9

Minimum number of units required for degree: 361

Computer Science with an Additional Major in Engineering
and Public Policy

Sophomore Year		Units
	Fall	
15-123	Same	9
15-212	Same	12
21-241	Same	9
xx-xxx	Same	9
73-100	Principles of Economics ⁺	9
19-102	EPP Sophomore Seminar	3

		51
	Spring	
15-213	Same	12
15-221	Same	9
15-xxx	Same	9
xx-xxx	EPP Technical Elective (must meet CS E/S restrictions)	9
xx-xxx	EPP Social Analysis Elective*	9

Junior Year		Units
	Fall	
15-451	Same	9
15-xxx	Same	9
36-217	Probability Theory and Random Processes	9
xx-xxx	EPP Technical Elective	9
xx-xxx	EPP Social Analysis Elective*	9

		45
	Spring	
15-xxx	Same	12
15-xxx	Same	9
19-451	EPP Project	12
xx-xxx	EPP Social Analysis Elective*	9

Senior Year		Units
	Fall	
15-xxx	Same	12
19-452	EPP Project	12
xx-xxx	EPP Social Analysis Elective*	9
xx-xxx	EPP Technical Elective	9

		42
	Spring	
15-xxx	Same	9
36-220	Engr Stats and Quality Control	9
xx-xxx	EPP Technical Elective	9
xx-xxx	EPP Social Analysis Elective*	9

Minimum number of units required for degree: 370

* One Social Analysis Elective must be a Decision Analysis course from the following list:
88-223 Decision Analysis and Decision Support Systems
88-302 Behavioral Decision Making

+ 73-100, Principles of Economics, satisfies the BSCS category 2 breadth requirement and is also required for the CS/EPP double major.

Electrical and Computer Engineering
 Single Major

Sophomore Year		Units
	Fall	
18-200	Emerging Trends in ECE	1
18-2x0	ECE Core Course	12
18-202	Mathematical Foundations of Electrical Engineering	12
	or	
21-127	Introduction to Modern Mathematics (18-240 co req)	9
33-107	Physics for Engineering Students II	12
xx-xxx	General Education Course	9

 43 / 46

Spring		Units
18-2x0	ECE Core Course	12
18-202	Mathematical Foundations of Electrical Engineering	12
	or	
21-127	Introduction to Modern Mathematics (18-240 co req)	9
15-123	Effective Programming in C and Unix	9
xx-xxx	General Education Course	9
xx-xxx	Free Elective	9

 48 / 51

Junior Year		Units
	Fall	
xx-xxx	ECE Breadth Course 1	12
15-213	Introduction to Computer Systems	12
36-217	Probability Theory and Random Processes	9
xx-xxx	General Education Course	9
xx-xxx	Free Elective	9

 51

Spring		Units
18-290	Signals and Information Processing	12
xx-xxx	ECE Breadth Course 2	12
xx-xxx	Math / Science Elective 1	9
xx-xxx	General Education Course	9
xx-xxx	Free Elective	9

 51

Senior Year		Units
	Fall	
18-xxx	ECE Capstone Course	12
18-xxx	ECE Depth Course	12
xx-xxx	General Education Course	9
xx-xxx	Math / Science Elective 2	9
xx-xxx	Free Elective	9

 51

Spring		Units
18-xxx	ECE Coverage Course	12
xx-xxx	General Education Course	9
xx-xxx	Free Elective	9
xx-xxx	Free Elective	9
xx-xxx	Free Elective	6

 45

Minimum number of units required for degree: 379

 Electrical and Computer Engineering with an Additional
 Major in Engineering and Public Policy

Sophomore Year		Units
	Fall	
18-200	Same	1
18-2x0	Same	12
18-202	Same	12
	or	
21-127	Same	9
33-107	Same	12
73-100	Principles of Economics	9
19-102	EPP Sophomore Seminar	3

 46 / 49

Spring		Units
18-2x0	Same	12
18-202	Same	12
	or	
21-127	Same	9
15-123	Same	9
xx-xxx	EPP Social Analysis Elective	9
xx-xxx	EPP Social Analysis Elective	9

 48 / 51

Junior Year		Units
	Fall	
xx-xxx	Same	12
15-213	Same	12
36-217	Same	9
xx-xxx	EPP Technical Elective	9
xx-xxx	Math / Science Elective 1	9

 51

Spring		Units
18-290	Same	12
xx-xxx	Same	12
19-451	EPP Project	12
xx-xxx	EPP Social Analysis Elective*	9

 45

Senior Year		Units
	Fall	
18-xxx	Same	12
18-xxx	Same	12
xx-xxx	EPP Social Analysis Elective*	9
19-452	EPP Project	12
xx-xxx	EPP Social Analysis Elective	9

 54

Spring		Units
18-xxx	Same	12
xx-xxx	EPP Technical Elective	9
36-217/220	Second Statistics Course	9
xx-xxx	EPP Social Analysis Elective	9
xx-xxx	EPP Technical Elective	9

 48

Minimum number of units required for degree: 382

* One of these must be taken from the following list:

- 88-302 Behavioral Decision Making
- 88-223 Decision Analysis and Decision Support Systems

Materials Science and Engineering
Single Major

Sophomore Year		Units
Fall		
21-259	Calculus in Three Dimensions	9
21-126	Introduction to Mathematical Software	3
33-107	Physics for Engineering Students II	12
27-299	Professional Development I	1
27-215	Thermodynamics of Materials	12
27-201	The Structure of Materials	6+3
27-202	Defects in Materials	6+3
		55
Spring		
21-260	Differential Equations	9
09-105	Modern Chemistry I	10
09-101	Introduction to Experimental Chemistry	3
27-216	Transport in Materials	9
27-205	Introduction to Material Characterization	3
27-217	Phase Relations and Diagrams	9+3
xx-xxx	H&SS Elective	9
		55
Junior Year		
Fall		
33-225	Quantum Physics and Structure of Matter	9
or		
09-117	Organic Chemistry	9
or		
03-121	Modern Biology	9
27-399	Professional Development II	1
27-xxx	MSE Restricted Elective [1]*	9
27-301	Microstructure and Properties I	6+3
xx-xxx	Free Elective	9
xx-xxx	H&SS Elective	9
		46
Spring		
36-220	Engineering Statistics and Quality Control	9
27-xxx	MSE Restricted Elective [2]	9
xx-xxx	Free Elective [2]	9
xx-xxx	Free Elective [3]	9
27-367	Selection and Performance	6
xx-xxx	H&SS Elective	9
		51
Senior Year		
Fall		
27-401	MSE Capstone Course	12
27-499	Professional Development III	1
27-xxx	MSE Restricted Elective [3]	9
xx-xxx	Free Elective [4]	9
xx-xxx	H&SS Elective	9
xx-xxx	H&SS Elective	9
		49
Spring		
27-xxx	MSE Restricted Elective [4]	9
27-xxx	MSE Restricted Elective [5]	9
xx-xxx	Free Elective [5]	9
xx-xxx	H&SS Elective	9
		36

Minimum number of units required for degree: 379

* MSE single major restricted electives must total 45 units in any combination of appropriate courses. 9 unit examples are shown.

Materials Science and Engineering with an Additional Major
in Engineering and Public Policy

Sophomore Year		Units
Fall		
21-259	Same	9
21-126	Same	3
33-107	Same	12
(Seminar requirement is met by 19-102)		
27-215	Same	12
27-201	Same	6+3
27-202	Same	6+3
19-102	EPP Sophomore Seminar	3
		57
Spring		
21-260	Same	9
09-105	Same	10
09-101	Same	3
27-216	Same	9
27-205	Same	3
27-217	Same	9+3
73-100	Principles of Economics	9
		55
Junior Year		
Fall		
33-225	Same	9
or		
09-117	Same	9
or		
03-121	Same	9
(Seminar requirement is met by 19-102)		
27-xxx	Same	9
27-301	Same	6+3
xx-xxx	EPP Social Analysis Elective*	9
xx-xxx	EPP Social Analysis Elective*	9
		45
Spring		
36-220	Same	9
27-xxx	Same	9
xx-xxx	EPP Technical Elective	9
19-451	EPP Project	12
26-367	Same	9
xx-xxx	EPP Social Analysis Elective*	9
		57
Senior Year		
Fall		
27-401	Same	12
(Seminar requirement is met by 19-102)		
27-xxx	Same	9
xx-xxx	EPP Technical Elective	9
19-452	EPP Project	12
xx-xxx	EPP Social Analysis Elective*	9
		51
Spring		
27-xxx	Same	9
(Per catalog double majors take 36 vs 45 units of restricted electives)		
36-310	Fundamentals of Statistical Modeling	9
xx-xxx	EPP Social Analysis Elective*	9
xx-xxx	EPP Technical Elective	9
		36

Minimum number of units required for degree: 385

* One of these must be taken from the following list:

- 88-302 Behavioral Decision Making
- 88-223 Decision Analysis and Decision Support Systems

**Mechanical Engineering
Single Major**

Sophomore Year		Units
	Fall	
21-259	Calculus in Three Dimensions	9
24-221	Thermodynamics I	10
24-261	Statics	10
xx-xxx	Restricted Technical Elective	10-13
xx-xxx	General Education Course	9

		48-51
	Spring	
21-260	Differential Equations	9
24-231	Fluid Mechanics	10
24-262	Stress Analysis	12
xx-xxx	Restricted Technical Elective	10-13
xx-xxx	General Education Course	9

Junior Year		Units
	Fall	
24-302	Mechanical Engineering Seminar	(2)
24-311	Numerical Methods	12
24-322	Heat Transfer	10
24-351	Dynamics	10
36-220	Engineering Statistics and Quality Control	9
xx-xxx	General Education Course	9

		50(52)
	Spring	
24-370	Design I: Methods and Skills	12
24-302	Mechanical Engineering Seminar (If not taken in fall) (2)	(2)
24-321	Thermal-Fluids Experimentation and Design	12
24-352	Dynamic Systems and Control	12
xx-xxx	General Education Course	9

Senior Year		Units
	Fall	
24-452	Mechanical Systems Experimentation	9
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9

		45
	Spring	
24-441	Design II: Conceptualization and Realization	12
24-xxx	Mechanical Engineering Technical Elective	9-12
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9

48-51

Minimum number of units required for degree: 380

**Mechanical Engineering with an Additional Major in
Engineering and Public Policy**

Sophomore Year		Units
	Fall	
21-259	Same	9
24-221	Same	10
24-261	Same	10
xx-xxx	Same	10-13
73-100	Principles of Economics	9
19-102	EPP Sophomore Seminar	3

		51-54
	Spring	
21-260	Same	9
24-231	Same	10
24-262	Same	12
xx-xxx	Same	10-13
xx-xxx	EPP Social Analysis Elective	9

Junior Year		Units
	Fall	
	(Seminar requirement is met by 19-102)	
24-311	Same	9
24-322	Same	10
24-351	Same	12
36-220	Same	9
xx-xxx	EPP Social Analysis Elective*	9

		50
	Spring	
24-370	Same	12
	(Seminar requirement is met by 19-102)	
24-321	Same	12
24-352	Same	12
19-451	EPP Project I	12

Senior Year		Units
	Fall	
24-452	Same	9
xx-xxx	EPP Technical Elective	9
19-452	EPP Project	12
xx-xxx	EPP Technical Elective	9
xx-xxx	EPP Social Analysis Elective*	9

		48
	Spring	
24-441	Same (Counts as 4 th EPP Tech Elective)	12
36-310	Fundamentals of Statistical Modeling	9
xx-xxx	EPP Technical Elective	9
xx-xxx	EPP Social Analysis Elective*	9
xx-xxx	EPP Social Analysis Elective	9

48

Minimum number of units required for degree: 387

* One of these must be taken from the following list:
 88-302 Behavioral Decision Making
 88-223 Decision Analysis and Decision Support Systems

Engineering and Public Policy

Undergraduate / Graduate Level Courses

Many courses taught by the department (19-XXX courses) are offered to undergraduate and graduate students. These "dual level" courses are offered in two formats:

- Some courses are taught under both an undergraduate and graduate number. An example is 19-402 / 19-712 Telecommunications Technology, Policy and Management. In these types of courses, students who sign up under the 700-level (graduate) course number may be expected to perform the same coursework at a higher level, and / or complete additional coursework, compared to 19-4XX students. Undergraduates who choose to take the course under the graduate number will be also be expected to work at the higher expectation / coursework level.
- Other courses are taught under a 600 level number. An example is 19-650 Climate and Energy: Science and Public Policy. These courses may be taken by undergraduates as a senior level course, or by graduate students as a graduate level course. As with dual number courses, graduate level students, or undergraduates taking the course for graduate credit, may be required to perform coursework at a higher level and / or complete additional coursework. Undergraduates who are taking a 600 level course for graduate credit should identify this fact to both the course instructor and to their EPP department advisor.

Students who have questions about the requirements of a specific EPP 400 / 700, or 600 level course, should contact the course instructor.

Other departments may have different policies regarding courses offered under both an undergraduate and graduate number, and courses offered under numbers other than the 100, 200, 300, 400, or 700 levels. Students who wish to take these courses should check with those departments for their specific policies.

Faculty

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Materials Science and Engineering

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Essentially every technology depends on materials development and innovation. Novel technologies are often initiated based on materials innovations, while conventional technologies rely on materials development to either reduce production cost or respond to mandates of the marketplace. The overarching paradigm of materials science and engineering is to exploit the connection between processing, microstructure and the properties of a material in order to choose a material that will fit the performance criteria for a given application. Thus, in Materials Science and Engineering, one must develop: (1) an understanding of current materials and their applications; (2) an ability to further improve current materials; and, (3) an ability to understand the potential applications of new materials, as they are developed. In addition to this product specific knowledge, a Materials Engineer must understand the implications of Materials processing routes on the environment and energy resources and must be involved in life cycle analysis to ensure that the material can be properly produced, used and recycled in a sustainable manner.

Materials Science & Engineering is therefore the discipline that applies the tools of basic and applied science to the processing, manufacture and application of materials and devices. Graduates of the MSE department are pursuing careers in an expanding spectrum of companies, national laboratories, and universities. Their activities cover a wide range of materials related endeavors that include microelectronics, energy production and storage, biomedical, biotechnology, aerospace, information technology, nanotechnology, manufacturing and materials production. Our undergraduates are encouraged to participate in the current research programs of the faculty and a majority of our students conduct undergraduate research projects as part of their program.

Materials subjects fall into three broad areas: (1) materials characterization, (2) the synthesis and processing of materials in order to obtain desired properties, and (3) the ability to understand and predict the behavior of materials under diverse conditions. Due to the need to understand materials microstructure, chemistry and properties, students in Materials Engineering learn techniques of materials characterization in the digital microscopy classroom (<http://materials.cmu.edu/degreaef/MCL.shtml>) in the J. Earl and Mary Roberts Materials Characterization Laboratory, a state of the art facility for materials characterization within the department.

Materials Science and Engineering is the overarching term describing specific interests in metals, polymers, ceramics, composites and electronic materials. It has become increasingly clear that the properties of all these types of materials are related fundamentally through parameters that describe internal structure. Furthermore, it has been found that the equipment and instrumentation, as well as the theoretical and analytical tools, which are necessary to process, study and understand one type of material are often well suited for others. Thus a common set of tools and understanding has been developed that applies to the complete spectrum of materials types, including ceramics, polymers, metals, semiconductors and composites, etc.

The standard curriculum of the department provides fundamental training for all of materials science and engineering areas (http://materials.cmu.edu/ugrad/std_fresh.html). The core courses provide understanding and tools for working with the (atomic) structure of materials, the defects (dislocations, interfaces etc.) that largely govern their properties, the thermodynamic relationships that govern the stability of materials, and the rates at which changes take place in materials. The paradigm of materials science is that one must understand the internal or surface structure of materials in order to predict and engineer their properties: this is addressed in the core courses on "Microstructure & Properties" and "Selection & Performance" of materials. There is also a capstone design experience in the final year that is aimed at integration of knowledge and team skill development. The elective program allows the attainment of excellence in a student's chosen specialty, whether it is ceramics, semiconductors, metals, composites, magnetic or optical materials, biomaterials or polymers. The option of concentration in the one or more of the areas of electronic materials*, engineering design*, biomedical engineering*,

environmental engineering*, manufacturing engineering*, mechanical behavior of materials*, biomedical and health engineering**, and engineering and public policy**, is available. (*= Designated Minor, **= Double Major). In addition, a number of elective tracks have been developed to aid the student in choosing various courses of specialization in the electives. (<http://neon.mems.cmu.edu/MSE/tracks.html>)

Based on the broad range of destinations for graduates of the MSE program, our curriculum is designed to provide a strong foundation in fundamental knowledge and skills. This provides an excellent basis for the substantial fraction of our graduates who go on to graduate school. For the equally substantial fraction of our graduates who find employment in industry, the program provides the foundation on which a graduate can build his/her domain specific knowledge. For those individuals who move on to other areas, the MSE curriculum provides a modern liberal education, i.e. one that inculcates a thoughtful, problem-solving approach to professional life. It is thus the goal of our education to provide a general education in Materials Science and Engineering that will enable our graduates to easily switch between materials industries as their career develops or to go to any of the leading institutions of graduate education in Materials and be successful.

Educational Objectives

All ABET accredited academic programs publish long term program objectives, along with statements that describe what students are expected to know or be able to do by the time of graduation from the program. The faculty of the Department of Materials Science and Engineering, in consultation with students, alumni and other interested parties, has decided that the overarching objective of the MSE curriculum is to provide an education that enables our graduates to be productive and fulfilled professionals throughout their careers.

Specifically, our program will produce graduates who:

- (1) are successful in a top graduate school and/or in materials engineering positions;
- (2) excel in professionalism and leadership in modern materials engineering practice, while accounting for the impact of their profession on an evolving society;
- (3) creatively advance our collective understanding of the principles of materials science and engineering and/or innovate the design of technological systems;
- (4) contribute effectively as an individual, team member, or a leader to achieve group and institutional goals.

Based on these objectives, our program is focused to allow our students to be successful regardless of their future career choice.

Outcome Definitions for MSE

The Department of Materials Science and Engineering has accepted the following definitions for the educational outcomes of the department; these outcomes will allow our students to be successful in any career choice and achieve the long term objectives of our department.

MSE Outcome A:

An ability to apply a knowledge of mathematics, physics, chemistry, materials and statistics to identify, formulate and solve the problems encountered in the production or application of a material.

MSE Outcome B:

An ability to apply core concepts in materials science (structure, properties, processing and performance) to identify, formulate and solve contemporary materials engineering problems.

MSE Outcome C:

An ability to communicate effectively.

MSE Outcome D:

An ability to design and conduct experiments and to analyze and interpret the data derived from these experiments with an emphasis on relating properties and processing to structure and on relating structure and properties to materials performance.

MSE Outcome E:

An ability to select materials to meet relevant performance criteria during the design of engineered systems and components within realistic constraints.

MSE Outcome F:

An ability to function responsibly and ethically in a professional, multidisciplinary environment as an individual or as a member of a team.

MSE Outcome G:

An ability to employ the techniques, skills and tools of modern materials engineering practice.

MSE Outcome H:

A recognition of the need for lifelong scholarship as the field of materials is continually evolving as new knowledge and materials are developed.

MSE Outcome I:

A knowledge of contemporary issues in the application of materials.

MSE Outcome J:

The broad education necessary to understand the impact of materials engineering solutions in a global and societal context.

Industrial Intern Program

An industrial internship option (IIO - cooperative educational program) within the department offers an MSE student an opportunity to obtain valuable experience and insight from alternating periods in industry and on campus (beginning the spring after the sophomore year). The combination of learning while participating in an industrial environment with academic course work creates strongly motivated students and a personalized learning situation. Graduation with a B.S. degree occurs four and one-third calendar years after entering the university. Exceptionally able students may be admitted to a program leading to both the B.S. and M.S. degrees in five years. Students in the IIO program should consult with their faculty advisors before electing to participate in any of the designated minor programs.

Following the standard or industrial internship programs the graduate of the Department of Materials Science and Engineering is well prepared for leadership in our highly technological society which continues to demand more and more from the materials used in engineered systems. Many of our graduates elect to continue their education to the Master's and Doctoral Level in order to satisfy their need for advanced education in the discipline.

Standard Program

Freshman Year

Fall	Units	
21-120	Differential and Integral Calculus	10
33-106	Physics for Engineering Students I #	12
27-100	Engineering the Materials of the Future*	12
xx-xxx	H&SS Elective [1]	9
		43

Spring

21-122	Integration, Differential Equations and Approximations	10
15-100	Introductory Programming	10
xx-xxx	Introductory Engineering Elective	12
xx-xxx	H&SS Elective [2]	9
99-10x	Computing @ Carnegie Mellon	3
		44

Sophomore Year

Fall		
21-259	Calculus in Three Dimensions	9
21-126	Introduction to Mathematical Software	3
33-107	Physics for Engineering Students II**	12
27-299	MSE Professional Development I	1
27-215	Thermodynamics of Materials	12

27-201	Structure of Materials	6+3
27-202	Defects in Materials	6+3
		55
Spring		
21-260	Differential Equations	9
09-105	Intro to Modern Chemistry I**	10
09-101	Introduction to Experimental Chemistry**	3
xx-xxx	H&SS Elective [3]	9
27-216	Transport in Materials	9
27-217	Phase Relations and Diagrams	9+3
27-205	Introduction to Materials Characterization	3
		55

Junior Year

Fall		
xx-xxx	Free Elective [1]	9
33-225	Quantum Physics and Structure of Matter	9
or		
09-217	Organic Chemistry I	9
or		
03-121	Modern Biology	9
xx-xxx	H&SS Elective [4]	9
27-399	MSE Professional Development II	1
27-xxx	MSE Restricted Elective [1]	9
27-301	Microstructure and Properties I	6+3
		46
Spring		
xx-xxx	Free Elective [2]	9
xx-xxx	Free Elective [3]	9
36-220	Engineering Statistics and Quality Control	9
xx-xxx	H&SS Elective [5]	9
27-xxx	MSE Restricted Elective [2]	9
27-367	Selection and Performance	6
		51

Senior Year

Fall		
xx-xxx	Free Elective [4]	9
xx-xxx	H&SS Elective [6]	9
xx-xxx	H&SS Elective [7]	9
27-499	MSE Professional Development III	1
27-xxx	MSE Restricted Elective [3]	9
27-401	MSE Capstone Course	12
		49
Spring		
xx-xxx	Free Elective [5]	9
xx-xxx	H&SS Elective [8]	9
27-xxx	MSE Restricted Elective [4]	9
27-xxx	MSE Restricted Elective [5]	9
		36

Minimum number of units required for degree: 379

* The Materials in Engineering course 27-100 may also be taken in the spring semester, and must be taken before the end of the sophomore year (the H&SS Elective in the Sophomore Spring may be moved to later in the program to accommodate the 27-100 course).

** These courses must be taken before the end of the sophomore year, but need not be taken in the same order or semester as listed above.

The recommended sequence is 33-106/107 for Engineering students. However, 33-111/112 or 33-131/132 will also meet the CIT Physics requirement.

Notes on the Curriculum

Quality Point Average

In addition to the College requirement of a minimum cumulative quality point average of 2.00 for all courses taken beyond the freshman year, the Department requires a quality point average of 2.00 or higher in courses taken in the MSE department. Students may repeat a course to achieve the QPA requirement. Only the higher grade will be used for this departmental calculation.

MSE Restricted Electives

The MSE Restricted Electives are listed below. Each student in the Standard or Industrial Internship program must take at least 45 units from this list. In double major programs at least 36 units are required. The total number of units may be reached through any combination of the courses below.

27-302	Microstructure and Properties II
27-322	Processing of Metals
27-323	Powder Processing of Materials

27-324	Introduction to Polymer Science and Engineering
27-325	Polymer Physics and Morphology
27-402	MSE Capstone Course II
27-405	Analysis and Prevention of Product Failures
27-410	Computational Techniques in Engineering Processing Design
27-421	Electronic and Thermal Properties of Metals, Semiconductors and Related Devices
27-432	Dielectric, Magnetic and Superconducting Properties of Materials
27-433	Deformation Processing
27-442	Structure, Properties and Performance Relationships in Magnetic Materials
27-445	Supervised Reading
27-454	Introduction to Biomaterials I
27-510	Introduction to Biomaterials II
27-511	Diffraction Methods in Materials Science
27-512	Advanced Physical Metallurgy
27-530	Principles of Growth and Processing of Semiconductors
27-533	Processing and Properties of Thin Films
27-542	Properties of Ceramics and Glasses
27-551	Materials Project I
27-555	Materials Project II
27-556	Physical Chemistry of Metallurgical Reactions
27-560	Nanostructured Materials
27-565	Special Topics
27-566	Phase Transformations in Solids
27-582	Mechanical Behavior of Materials
27-591	Solidification Processing
27-592	Electrochemical Processes in Materials
27-594	Experimental Polymer Science
06-466	Physical Chemistry of Macromolecules
06-609	Semiconductor Processing Technology
06-619	Experimental Polymer Science
12-605	Design and Construction
12-411	Engineering Economics
12-611	Project Management Construction
12-631	Structural Design
18-311	Semiconductor Devices I
18-412	Semiconductor Devices II
24-262	Stress Analysis
24-341	Manufacturing Sciences
24-361	Intermediate Stress Analysis
24-401	Engineering Analysis
33-341	Thermal Physics I
33-448	Introduction to Solid State Physics
42-644	Medical Devices
39-500	CIT Honors Project
42-300	Junior BME Research Project
42-400	Senior BME Research Project

MSE graduate courses may also be counted as restrictive electives subject to approval by Undergraduate advisors.

Industrial Internship Option (Cooperative Education Program)

The industrial internship option (IIO) unique to the Department offers the student in Materials Science and Engineering an opportunity to supplement the regular academic program with valuable practical experience through alternating periods in industry and on campus, beginning in the Spring of the sophomore year. Interested students should apply for this option during the first semester of the sophomore year and are expected to follow the program, including four industry periods, to completion.

Standard Program

Sophomore Year

Fall
Standard Program for the Fall semester; co-op interviews in Fall

Spring
Industry 1

Summer		
21-260	Differential Equations	9
xx-xxx	H&SS Elective [3]	9
xx-xxx	H&SS Elective [4]	9
xx-xxx	H&SS Elective [5]	9

Junior Year

Fall
Industry 2

Spring		
09-105	Introduction to Modern Chemistry 1**	10
09-101	Introduction to Experimental Chemistry**	3
xx-xxx	H&SS Elective [6]	9
27-xxx	MSE Restricted Elective [1]	9
27-216	Transport in Materials	9
27-217	Phase Relation and Diagrams	9+3
27-205	Introduction to Materials Characterization	3

Summer
Industry 3

Senior Year

Fall		
xx-xxx	Free Elective [1]	9
33-225	Quantum Physics and Structure of Matter	9
or		
09-217	Organic Chemistry I	9
or		
03-121	Modern Biology	9
xx-xxx	H&SS Elective [7]	9
27-399	MSE Professional Development II	1
27-xxx	MSE Restricted Elective [2]	9
27-301	Microstructure and Properties I	6+3

Spring		
xx-xxx	Free Elective [2]	9
xx-xxx	Free Elective [3]	9
36-220	Engineering Statistics & Quality Control	9
xx-xxx	H&SS Elective [8]	9
27-xxx	MSE Restricted Elective [3]	9
27-367	Selection and Performance	6

Summer
Industry 4

Fifth Year

Fall		
xx-xxx	Free Elective [4]	9
xx-xxx	Free Elective [5]	9
27-499	MSE Professional Development III	1
27-xxx	MSE Restricted Elective[4]	9
27-xxx	MSE Restricted Elective[5]	9
27-401	MSE Capstone Course	12

Minimum number of units required for degree: 379

* The 5 MSE Restricted Electives are listed above as 9 unit courses. The student must complete at least 45 units of MSE Restricted Electives, and may combine 6 and 9 unit courses to reach or exceed this total.

** See remark after Standard Program.

Integrated B.S./M.S. Program

Undergraduates have the opportunity to receive simultaneously or be sequentially awarded B.S. and M.S. degrees in MSE by taking an additional 96 units of coursework at Carnegie Mellon. The primary purpose of the Integrated Masters/ Bachelor Degree Program is to provide students with superior breadth and depth in technical material, which will better prepare them for careers in industry. The Integrated Masters/Bachelor Degree Program normally requires an additional academic year of coursework beyond the B.S. Degree Requirements. However, students interested in pursuing the Integrated M.S./B.S. Degrees are encouraged to begin taking some of the required graduate courses before their last year.

Degree Requirements

The following are the additional requirements for the Integrated M.S./B.S. Degrees over and above the requirements for the B.S. Degree. Note that no course can be counted as satisfying more than one of the requirements listed below and no course used to satisfy the B.S. Degree requirements can be used to satisfy one of the requirements listed below. The requirements total 96 units. The 96 additional units needed to satisfy the M.S. degree component of the Integrated Program can not be used to satisfy any other requirements such as a double major or minor.

1. Course Option (96 units)

27-780 Thermodynamics
27-788 Defects in Materials
27-766 Diffusion in Materials
27-796 Structure of Materials
27-797 Bonding of Materials

- plus 60 units of 500 or 700 level Materials Science and Engineering courses.

2. Research Option (30 units, Summer 4-th year)

27-780 Thermodynamics
27-788 Defects in Materials
27-766 Diffusion in Materials
27-796 Structure of Materials
27-797 Bonding of Materials

- plus 30 units of 500 or 700 level Materials Science and Engineering courses.
- plus 30 units of 27-756 Masters project (usually taken in the summer of the fourth year).

The Integrated B.S./M.S. Degree Program is available to all under-graduates who maintain a cumulative QPA of 3.0 or better, including the freshman year. Students must also maintain a QPA of 3.0 in courses used to satisfy the requirements of the M.S. degree. No course with a grade lower than C will be counted toward the Master's Degree requirements (those over and above the requirements for the B.S. Degree).

Students (with a cumulative QPA of 3.0 or higher) become eligible to apply to the program during the spring semester of their junior year, or the semester in which they accumulate 280 or more units, whichever is earlier. Interested students should apply to the Department Head of Materials Science and Engineering prior to February 15 of their junior year.

As with all M.S. Degrees in the Department of Materials Science and Engineering, students must pass the master's comprehensive examination which should be taken near the end of the Spring semester of the fourth year. Although some specific graduate courses are required above, substitutions are permitted within the freedom of the normal requirements for the M.S. degree (see graduate curriculum information for further details). Students interested in a program with a strong research orientation are encouraged to elect 27-402 MSE Capstone Course II as part of their undergraduate program.

Faculty

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Department of Mechanical Engineering

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The profession of mechanical engineering, second largest among engineering disciplines, involves the design, analysis, and manufacturing of new products and technologies. Central to the profession is the importance of innovation in applying mechanical engineering fundamentals to address society's needs. The Department's curriculum is structured to provide students with the analytical tools, technical skills, engineering insights, and practical problem solving abilities that are necessary to convert a concept into a reliable, cost-effective, and safe device.

Mechanical engineers are employed by small start-ups, multinational corporations, government agencies, national laboratories, consulting firms, and universities. They can work in the areas of research, design, manufacturing, sales, quality assurance, or management. Mechanical engineers work in teams that design jet engines; automobiles; aircraft and spacecraft; microelectromechanical acceleration and pressure sensors; heating, ventilation, and air conditioning systems; power generation systems; biomedical and biomechanical devices such as artificial hip implants; and such integrated mechanical and electronic (mechatronic) systems as robots. The Department of Mechanical Engineering at Carnegie Mellon University is respected for the many significant advances in these technologies and others that have been made by its alumni and faculty.

The Department's curriculum provides students with a solid foundation upon which they can build to meet the challenges associated with their individual career paths, and to adapt to the rapidly changing technologies faced by today's engineers. Early in their education, Carnegie Mellon students develop a strong scientific foundation by taking courses in mathematics, physics, computer programming, and chemistry. In addition, all students are exposed at the Freshman level to two engineering disciplines through introductory courses taught by each department in the engineering college. The Department's Freshman-level course is project-oriented, and it introduces students to the various disciplines of mechanical engineering through lecture, laboratories, and hands-on learning. In the Sophomore and Junior years, students take core engineering courses in solid and fluid mechanics, thermodynamics, heat transfer, dynamics, systems and controls, design methods and skills and numerical methods.

While the program's emphasis on fundamentals is demanding, the Department's curriculum is also flexible and enables students to (i) begin taking elective courses during the Junior year, (ii) develop a specialization within mechanical engineering, (iii) develop a technical emphasis within another engineering or science department, or (iv) pursue studies in any other Carnegie Mellon department, such as foreign languages, economics, or design. This approach to engineering education recognizes the broader role that mechanical engineers play in society, as leaders in business, government, and law. During the Senior year, students take electives and capstone courses in engineering analysis and design with projects that often result in prototype hardware for new products. Students work in teams, on projects of their choosing, and are exposed to the design process from conceptualization to production. Recent examples include low-squeal disk brakes, high efficiency engines, neck gear to minimize spinal cord injury in sports, a stabilizer support arm for movie cameras, and equipment to improve the mobility of disabled persons. Effective writing, speaking and presentation skills, and engineering ethics are also emphasized as important attributes of successful leaders.

Throughout the undergraduate program, beginning in the first year, students use the latest computer-based design and analysis methods in their courses and project work. An undergraduate computing laboratory is available for design work, structural and thermal/fluid finite element analyses, and dynamic system simulations. Students work with industry-standard computer aided design tools to develop engineering drawings, and to visualize the performance of those parts through computer simulation before they are fabricated. After the design is optimized, the computer model can be down-loaded to a multi-axis computer-controlled milling machine, from which the part is manufactured. Other resources within the Undergraduate Design and Manufacturing Laboratory include MIG welding, rapid prototyping, and a full

student shop equipped with lathes, drill presses, milling machines, band saws, and other hand and power tools. In coursework and projects, students work with state-of-the-art instrumentation and laboratory equipment, including spectrum analyzers, digital oscilloscopes, multi-waveform generators, and sensors which measure acceleration, strain, pressure, temperature, and force. Through such experiences, the Department emphasizes the modern industrial practice of seamlessly integrating computer-based design, analysis, characterization, and manufacturing.

Through electives and special degree programs, mechanical engineering students are able to pursue their personal interests both inside and outside the Department. Advanced courses in mechanical engineering are available in such areas as energy conversion, control, vibration, dynamics, manufacturing, robotics, internal combustion engines, mechatronics, fluid and solid mechanics, aerodynamics, and engineering design. Mechanical engineering students can also take a wide variety of technical and non-technical electives from other departments in order to develop a double major, minor, or concentration through an individualized program of study that is developed in collaboration with a faculty advisor. Many students choose to include a study abroad experience as part of their undergraduate education. The Department actively assists students in picking universities and courses abroad that will enhance their degree program. During their studies, many students also participate in faculty research projects, as laboratory assistants or through structured project work for academic credit. Students often find that exposure to solving open-ended research problems provides the ultimate educational experience.

The Department also offers an Accelerated Graduate Program, with access restricted to Carnegie Mellon undergraduates. In this program, students can take graduate courses during the Senior year in order to receive academic credit towards the Master's degree. After being admitted to the program, students can complete the coursework-based M.S. degree with only an additional summer and one semester of study beyond the traditional B.S. program.

In addition to teaching, the Department's faculty are actively involved in research sponsored by industry, consortia, and government agencies. Results of the research often serve as specific examples, case studies, and projects in undergraduate courses. Frequent seminars are sponsored by the Department, and they keep both students and faculty aware of recent advances in mechanical engineering and its related fields. Speakers of national and international reputation are invited to give these lectures. Seminars are open to all students within the Department, and they can provide students with a broad perspective on the mechanical engineering profession.

Additional information about the program is available through the Department's web page located at www.me.cmu.edu. The Department's Undergraduate Student Handbook includes further description of the Department's resources and policies. The handbook is distributed to sophomores in the Department each Fall, and is also available on-line at the Department's main web site. Additional copies can be requested in SH 416.

Educational Objectives

The highest-level objective of Carnegie Mellon University's mechanical engineering undergraduate program is to make positive, substantive, and lasting contributions to the lives of our students. This overall objective is articulated by the following two program educational objectives:

1. Graduates will recognize that they have obtained a high quality and rigorous technical education that is enriched by a flexible curriculum and interdisciplinary research opportunities.
2. Graduates will have applied their education to pursue successful career paths in either the engineering profession or an alternative field

The undergraduate curriculum in the Department of Mechanical Engineering offers students significant opportunities to pursue directions of personal interest, including minors, double majors, participation in research projects, and study abroad. Design and

teamwork experiences occur at regular intervals in the curriculum, and graduates have significant hands-on experience through laboratories and projects. The faculty of the Department has endorsed the following set of skills, or outcomes that graduates of the program are expected to have:

- an ability to apply knowledge of mathematics, science, and engineering
- an ability to design and conduct experiments, as well as to analyze and interpret data
- an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- an ability to function on multi-disciplinary teams
- an ability to identify, formulate, and solve engineering problems
- an understanding of professional and ethical responsibility
- an ability to communicate effectively
- the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- a recognition of the need for, and an ability to engage in life-long learning
- a knowledge of contemporary issues
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Overview of the Curriculum

The Department's program fully meets the requirements of an accredited curriculum in mechanical engineering as certified by the Accreditation Board for Engineering and Technology (ABET).

Curriculum

The following template for the four-year B.S. program depicts the standard and recommended course sequences. In order to ensure that prerequisites are satisfied, and to prevent scheduling conflicts, students should discuss any significant deviation from this exemplar with the department academic advisor.

Freshman Year

	Fall	Units
21-120	Differential and Integral Calculus	10
24-101	Fundamentals of Mechanical Engineering	12
33-106	Physics for Engineering Students I	12
99-101	Computing @ Carnegie Mellon	3
76-101	Interpretation and Argument	9
		44

	Spring	Units
21-122	Integration, Differential Equations, and Approximations	10
xx-xxx	Second Introductory Engineering Course	12
xx-xxx	Restricted Technical Elective	10-13
xx-xxx	General Education Course	9
		41-44

Sophomore Year

	Fall	Units
21-259	Calculus in Three Dimensions	9
24-221	Thermodynamics I	10
24-261	Statics	10
xx-xxx	Restricted Technical Elective	10-13
xx-xxx	General Education Course	9
		48-51

	Spring	Units
21-260	Differential Equations	9
24-231	Fluid Mechanics	10
24-262	Stress Analysis	12
xx-xxx	Restricted Technical Elective	10-13
xx-xxx	General Education Course	9
		50-53

Junior Year

	Fall	Units
24-302	Mechanical Engineering Seminar (or spring)	2
24-311	Numerical Methods	12
24-322	Heat Transfer	10
24-351	Dynamics	10
36-220	Engineering Statistics and Quality Control	9
xx-xxx	General Education Course	9
		52

	Spring	Units
24-370	Engineering Design I: Methods and Skills	12
24-321	Thermal Fluids Experimentation and Design	12
24-352	Dynamic Systems and Control	12
xx-xxx	General Education Course	9
		45

Senior Year

	Fall	Units
24-441	Design II: Conceptualization and Realization *or*	12
xx-xxx	Elective	9
24-452	Mechanical Systems Experimentation	9
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9
		48

	Spring	Units
24-441	Design II: Conceptualization and Realization *or*	12
xx-xxx	Elective	9
24-xxx	Mechanical Engineering Technical Elective	9-12
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	General Education Course	9
		45-51

Notes on the Curriculum

- A minimum of 380 units is required for completion of the B.S. degree.
- In the Freshman year, 24-101 Fundamentals of Mechanical Engineering can be taken in either the Fall or Spring semesters.

A second introductory engineering course is taken in the other semester of the Freshman year.

For those students who did not complete 24-101 Fundamentals of Mechanical Engineering during the Freshman year, this course should be taken during the Fall semester of the Sophomore year in place of the General Education Course. In this event, the replaced General Education Course should be taken during the Junior or Senior years. The additional introductory engineering course can be used to fulfill one of the Elective requirements as described below.

- By the end of the Sophomore year, a mechanical engineering student should have completed the following mathematics, computer science, and introductory engineering courses:

21-120	Differential and Integral Calculus	10
21-122	Integration, Differential Equations and Approximation	10
21-259	Calculus in Three Dimensions	9
21-260	Differential Equations	9
33-106*	Physics I for Engineering Students	12
33-107*	Physics II for Engineering Students	12
XX-XXX	Science Laboratory Requirement	3-12
09-105	Modern Chemistry 1	10
15-100	Introductory/Intermediate Programming	10
	or	
15-111	Intermediate/Advanced Programming	10
24-101	Introduction to Mechanical Engineering	12
xx-xxx	Second Introductory Engineering Course	12

* 33-106/107 is the recommended sequence for engineering students, although 33-111/112 or 33-131/132 would also meet the CIT Physics requirement.

Mechanical engineering undergraduates must satisfy a Science Laboratory requirement to graduate. Normally the Science Laboratory requirement is satisfied by passing 09-101 Introduction Experimental Chemistry (3 units). Students can also satisfy the Science Laboratory requirement by passing one of the following courses:

- a. 03-124 Modern Biology Laboratory (9 units)
- b. 33-100 Basic Experimental Physics (6 units)
- c. 33-104 Experimental Physics (9 units)
- d. 33-453 Intermediate Optics (12 units)
- e. 42-203 Biomedical Engineering Laboratory (9 units)

These courses may have prerequisites and tight enrollment limits that students should consider in their planning.

4. Students are required to complete 36-220, Engineering Statistics and Quality Control, which may be scheduled in any semester. The sequence of calculus courses (21-120, 21-122, 21-259) and Differential Equations (21-260) should be scheduled as indicated, due to Mechanical Engineering Core class prerequisites.
5. The communications requirement can be satisfied by completing at least one of the following options:
 - 24-302 ME Seminar (2 units either fall or spring)
 - 70-340 Business Communications (9 units)
6. In the Senior year, students enroll in Mechanical Systems Experimentation (24-452) in the fall. Engineering Design II (24-441) may be taken in either fall or spring.

Restricted Technical Electives

By the end of the Sophomore year, students should have completed each of the following courses, which are listed as "Restricted Technical Electives" in the exemplary curriculum. Students have some flexibility in the sequencing of these courses during the Freshman and Sophomore years:

	Units
33-107 Physics for Engineering Students II	12
09-101 Introduction to Experimental Chemistry	3
09-105 Modern Chemistry I	10
15-100 Introductory/Intermediate Programming	10
or	
15-111 Intermediate/Advanced Programming	10

Mechanical Engineering Technical Electives

Students are required to take at least one elective offered by the Department. These elective courses are listed as "Mechanical Engineering Technical Electives" in the exemplary curriculum. The courses below are grouped according to their discipline within mechanical engineering, and students can select courses from the same discipline or from different ones. Students must take at least one of the following courses for a minimum of 9 units to fulfill the Mechanical Engineering Technical Elective requirement:

Design and Manufacturing

24-201	Engineering Graphics
24-341	Manufacturing Sciences
24-443	Design for Manufacture

Mechanical Systems

24-353	Intermediate Dynamics
24-355	Kinematics and Dynamics of Mechanisms
24-356	Engineering Vibrations
24-361	Intermediate Stress Analysis
24-451	Feedback Control Systems

Thermal-Fluid Systems

24-331	Viscous Flow
24-332	Potential Flow and Aerodynamics
24-333	Gas Dynamics
24-415	Microfluidics
24-421	Internal Combustion Engines
24-423	Direct Energy Conversion
24-424	Energy and the Environment
24-425	Combustion and Air Pollution Control

Special Topics

24-380-386	Special Topics in Mechanical Engineering
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These courses are offered regularly according to the Department's teaching schedule. However, the offering of a particular course in a given semester can not be guaranteed.

24-391/392 Mechanical Engineering Project, 24-491/492 Departmental Research Honors, and 39-xxx series courses can not be used to satisfy the Mechanical Engineering Technical Elective requirement. However, those courses can be taken in the remaining five Elective slots.

Undergraduate students can also take certain graduate courses which are offered by the Department in order to satisfy the Mechanical Engineering Technical Elective requirement, provided

that the appropriate prerequisites have been met and the student has secured the approval of the course's instructor. Graduate courses offered by the Department are listed on the Department Website.

Electives

Students are required to complete five courses which are listed as "Electives" in the exemplary curriculum. These electives can be technical or non-technical courses. Only one such elective can be taken in the areas of Physical Education (69-xxx) or ROTC (30-xxx, 31-xxx, and 32-xxx).

Elective courses can be taken in the Mechanical Engineering Department, in other departments within the College of Engineering, or in any other department of the University. This feature of the curriculum is intended to provide students with sufficient flexibility to allow specialization in a wide variety of fields, and to facilitate minor and double major curricula.

Constructing a Program of Study

A total of six electives (one Mechanical Engineering Technical Electives and five Electives) are available to students. These courses should be selected through consultation with the academic advisor, and reflect long-term planning on the part of the student. For instance, the electives can be allocated in order to meet the requirements of minor, double major, or double degree programs. The Department's Undergraduate Student Handbook provides additional information on course and elective selection. Options available to students for structuring their programs of study include the following:

Specialization Within Mechanical Engineering

Students can develop deeper focus within mechanical engineering by using the Elective slots to take additional courses offered by the Department beyond the one required Mechanical Engineering Technical Elective. These courses can be chosen from the list of Mechanical Engineering Technical Electives, or from the list of the Department's graduate courses.

Research and Independent Study Projects

Students can pursue independent study within the Department on a design or research project under the supervision and coordination of a faculty advisor. Interested students are encouraged to contact faculty members and identify potential project areas of mutual interest. Mechanical engineering projects generally involve open-ended problem solving with laboratory, analytical, field, design, or computational work.

Students complete projects and research by taking either or both of the following courses within the Elective slots:

24-391/392	Mechanical Engineering Project
24-491/492	Departmental Research Honors

These courses do not qualify as Mechanical Engineering Technical Electives. There is no additional quality point average (QPA) requirement for students who choose to enroll in 24-391/392 Mechanical Engineering Project. Qualified students can pursue 24-491/492 Departmental Research Honors and receive such recognition at commencement. In order to graduate with research honors, a student must have attained a QPA of 3.2 or higher at graduation, have completed 18 units of 24-491/492 Departmental Research Honors in which grades of B or better were attained, and have submitted an approved thesis to the faculty advisor.

A student who completes all requirements for CIT Honors Research will also graduate with Departmental Research Honors upon completion of 18 units of 39-500 CIT Honors Research. Such research projects must be conducted under the supervision of a mechanical engineering faculty member.

Student-Structured Interdisciplinary Studies

Using the Elective slots, students can take courses outside the Mechanical Engineering Department in technical or non-technical areas. For instance, depending on a student's particular career interests, courses can be taken in such departments as Design, Biomedical Engineering, or Materials Science and Engineering, or through the College of Engineering's interdisciplinary 39-xxx series. Often, Elective courses are selected around a common theme that can span several departments, and are chosen so as to form a student-structured area of concentration. Such programs of study can be constructed in an informal manner by the student and his or her advisor, or they can be part of a minor or double major program.

Minors and Double Majors

The College of Engineering offers a series of designated minors in different areas of engineering specialization. The Elective, and Mechanical Engineering Technical Elective slots can be used to complete the requirements of these minors. Although students can generally complete a designated minor without increasing the number of units required for graduation, early planning is important.

Double major programs within the College of Engineering are also available. Students in the Department can earn double majors in (i) Mechanical Engineering, and Engineering and Public Policy, and (ii) Mechanical Engineering, and Biomedical and Health Engineering.

In addition, many departments in the University offer minor and double major degree programs. The Elective slots available to mechanical engineering students can be used to advantage in completing the requirements for a minor or double major, but early schedule planning is important. Interested students should contact the main office in the department of interest and inquire as to those requirements.

Advising

The department academic advisor is assigned initially to all new students and will continue to assist with any curriculum questions and registration issues for the remainder of their studies.

During the sophomore year, students are encouraged to request a faculty mentor. To assist in this process, students should attend the fall sophomore dinner to meet professors, utilize faculty introductions provided during sophomore core classes and check the website for additional faculty information (Current Students–Advising). Faculty appointments as needed may also be arranged through the academic advising office. The academic advisor will assign a faculty mentor to students that have not indicated a selection at the end of the sophomore year.

Faculty will:

- Explain technical content of coursework and suggest concentrations appropriate to career objectives
- Discuss research and summer internship opportunities
- Offer graduate school and employment path advice
- Offer general advice and mentoring

The Academic Advisor will:

- Verify progress toward degree requirements
- Discuss course alternatives for CIT requirements and electives
- Register research credit
- Assist with pre-requisite waivers
- Offer basic information regarding double major/minors, study abroad procedures, etc
- Explain summer transfer credit policies

As a regular part of monitoring progress toward completion of the degree, students should compare their transcripts with the department's degree requirements. Academic Audit – the HUB website– www.cmu.edu/hub.

Accelerated Graduate Program

An accelerated program is available to Carnegie Mellon undergraduate students who also wish to complete a coursework Master's degree in mechanical engineering. Exceptional students can apply for admission to the program at the end of the first semester of the Senior year and must meet the requirements for admission to the Department's graduate program. Financial aid in the form of Teaching or Research Assistantships is not offered to students in the Accelerated Graduate Program.

In this program, students must complete at least 24 units of graduate coursework by the end of the Senior year. A grade of 3.0 or better must be attained in those courses, and they can not be used to satisfy the requirements of the baccalaureate degree. During the summer immediately after the Senior year, students complete up to 24 units of 24–793 Supervised Reading and 24–794 Master of Science Project. During the following Fall semester, students then complete all remaining coursework. A total of 96 units is required for completion of the coursework Master's degree. Students who wish to pursue the Accelerated Graduate Program should contact the graduate coordinator in the Department's main office for further information.

Quality Point Average Requirements

In addition to the College of Engineering's requirement of a cumulative quality point average (QPA) of 2.00 or higher for all courses taken after the Freshman year, the Mechanical Engineering Department requires that students attain a quality point average of 2.00 or higher for all required Mechanical Engineering courses.

Pursuant to university rules, students can repeat a course in which a grade below C was attained in order to achieve the QPA requirement. The highest grade so obtained will be used to calculate the quality point average for all required Mechanical Engineering courses.

Faculty

ADNAN AKAY, Lord Professor of Mechanical Engineering — Ph.D., North Carolina State University; Carnegie Mellon, 1992—.

CRISTINA HORTENSIA AMON, Lane Distinguished Professor of Mechanical Engineering — Sc.D., Massachusetts Institute of Technology; Carnegie Mellon, 1988—.

SHELLEY ANNA, Associate Professor of Mechanical Engineering — Ph.D., Harvard University; Carnegie Mellon, 2003 —.

NADINE N. AUBRY, Professor of Mechanical Engineering; Head, Department of Mechanical Engineering – Ph.D., Cornell University; Carnegie Mellon, 2006.

JACK LEE BEUTH, Professor of Mechanical Engineering — Ph.D., Harvard University; Carnegie Mellon, 1992—.

JONATHAN CAGAN, Professor of Mechanical Engineering — Ph.D., University of California, Berkeley; Carnegie Mellon, 1990—.

NORMAN CHIGIER, Professor of Mechanical Engineering, Emeritus — Sc.D., University of Cambridge; Carnegie Mellon, 1981—.

JERRY HOWARD GRIFFIN, William J. Brown Professor of Mechanical Engineering — Ph.D., California Institute of Technology; Carnegie Mellon, 1980—.

C. FRED HIGGS III, Associate Professor of Mechanical Engineering — Ph.D., Rensselaer Polytechnic Institute; Carnegie Mellon University, 2003—.

LEVENT BURAK KARA, Assistant Professor of Mechanical Engineering — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2007—.

PHILIP R. LeDUC, Associate Professor of Mechanical Engineering — Ph.D., The Johns Hopkins University; Carnegie Mellon, 2002—.

SHAWN LITSTER, Assistant Professor of Mechanical Engineering — Ph.D., Stanford University; Carnegie Mellon, 2008—.

ALAN J.H. MCGAUGHEY, Assistant Professor of Mechanical Engineering—Ph.D., University of Michigan; Carnegie Mellon, 2005—.

WILLIAM CHARLES MESSNER, Professor of Mechanical Engineering — Ph.D., University of California, Berkeley; Carnegie Mellon, 1993—.

JEREMY J. MICHALEK, Assistant Professor of Mechanical Engineering — Ph.D., University of Michigan; Carnegie Mellon, 2005—.

JOHN FLETCHER OSTERLE, Theodore Ahrens Professor of Mechanical Engineering, Emeritus — D.Sc., Carnegie Mellon University; Carnegie Mellon, 1946—.

O. BURAK OZDOGANLAR, Associate Professor of Mechanical Engineering — Ph.D., University of Michigan; Carnegie Mellon, 2004—.

YOED RABIN, Professor of Mechanical Engineering — D.Sc., Technion–Israel Institute of Technology; Carnegie Mellon University, 2000—.

ALLEN L. ROBINSON, Professor of Mechanical Engineering, and Engineering and Public Policy — Ph.D., University of California, Berkeley; Carnegie Mellon, 1998—.

WILFRED THOMAS ROULEAU, Professor of Mechanical Engineering, Emeritus — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1954—.

EDWARD STEPHEN RUBIN, Professor of Mechanical Engineering and Engineering and Public Policy — Ph.D., Stanford University; Carnegie Mellon, 1969—.

KENJI SHIMADA, Professor of Mechanical Engineering — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1996—.

METIN SITTI, Associate Professor of Mechanical Engineering — Ph.D., University of Tokyo; Carnegie Mellon, 2002—.

PAUL SETH STEIF, Professor of Mechanical Engineering — Ph.D., Harvard University; Carnegie Mellon, 1983—.

JOHN WILLIAM WISS, Adjunct Professor of Mechanical Engineering — M.Mech.E., Rensselaer Polytechnic Institute; Carnegie Mellon, 1982—.

SHI-CHUNE YAO, Professor of Mechanical Engineering — Ph.D., University of California, Berkeley; Carnegie Mellon, 1977—.

YONGJIE ZHANG, Assistant Professor of Mechanical Engineering — Ph.D., University of Texas at Austin; Carnegie Mellon, 2007—.



The College of Fine Arts



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The College of Fine Arts

Hilary Robinson, Dean
College of Fine Arts, Rm. 100
Barbara Anderson, Associate Dean
Purnell Center for the Arts 332
Luis Rico-Gutierrez, Associate Dean
College of Fine Arts, Rm. 201

The College of Fine Arts at Carnegie Mellon University was founded in 1905 as the first comprehensive arts learning institution in the United States. For 104 years it has educated outstanding artists, architects, designers, theater artists and musicians who have made important contributions to culture in the United States and the world. The alumni of the College of Fine Arts have shaped the worlds of television, stage, film, and electronic media; are collected in numerous international museums; have composed for and are performing in and conducting major symphony orchestras, choruses and opera companies throughout the world; have built notable buildings, pioneered innovative sustainable design strategies and created interactive software systems; created significant innovations in graphic and industrial design; and are professors and deans in major arts institutions.

The College of Fine Arts concentrates on the education of professionals in the arts in the broader context of Carnegie Mellon University. Beyond their education in their chosen field, through required and elective course work, students are involved with other disciplines within the College of Fine Arts and within the other colleges of Carnegie Mellon University. Further, the College's location in the Oakland District of Pittsburgh with its broad cultural resources (The Carnegie Museum of Art, the Carnegie Museum of Natural History, The Carnegie Library, the University of Pittsburgh, The Hillman Library, the Frick Fine Arts Building, Phipps Botanical Conservatory, and the public television station WQED) places the College of Fine Arts at the center of a premier cultural environment.

The College of Fine Arts has a 9:1 student faculty ratio which provides a rigorous learning environment. It is a highly spirited federation of schools (Architecture, Art, Design, Drama and Music) made up of students and faculty who have an intense need to create and excel. Interacting among the schools, the University and the wider community are research centers such as the Studio for Creative Inquiry, the Center for Building Performance and Diagnostics and the Center for Arts in Society. The intellectual and artistic life of the College is interwoven with a dense calendar of theater performances, concerts, exhibitions, film and media presentations and lectures by visiting artists, practitioners and scholars.

The College of Fine Arts offers a wide range of professionally oriented majors and minors in each of its schools. In addition, the College offers the Bachelor of Humanities and Arts (BHA, jointly with The College of Humanities and Social Sciences), the Bachelor of Science and Arts (BSA, jointly with the Mellon College of Science), the Bachelor of Computer Science and Arts (BCSA, jointly with the School of Computer Science), and the Master of Arts Management (MAM) and Master of Entertainment Industry Management (MEIM), jointly with the Heinz School of Public Policy and Management). These are presented only briefly below, but a complete listing of the graduation requirements for these programs may be found in the school descriptions later in this section and elsewhere in this volume.

Architecture Office: CFA 201

The School of Architecture offers a five-year NAAB accredited Bachelor of Architecture undergraduate degree for students who seek professional careers in architectural practice. Beyond standard preparation in architectural design, history and representation, its curriculum stresses the centrality of aesthetics, scientific knowledge and tectonic resolution in the education of future practicing professionals. A core of university course work in mathematics, physical sciences, social sciences, writing and history is prerequisite to sequences in design, building and environmental technology, and architectural history. The school offers M.S. degrees in Architecture; Architecture, Engineering & Construction Management; Building Performance and Diagnostics; Computational Design; and Sustainable Design. In addition, the School offers a Masters of Urban Design and a Masters of Tangible Interaction Design. The School of Architecture has a well-known architectural Ph.D. program that provides qualified students with the opportunity to continue their studies in the areas of specialization for which the School is recognized.

Art Office: CFA 300

The primary mission of the School of Art is to develop in the individual student the skills, knowledge, and commitment required to work as an artist in society. The four-year undergraduate program leads to a Bachelor of Fine Arts degree in Art. Concentrations within the art major are offered in four areas: 1) Painting, Drawing, and Printmaking; 2) Electronic and Time-Based Work; 3) Sculpture, Installation, and Site Work; and 4) Contextual Practice. A Master of Fine Arts degree in Art is also offered.

Design Office: MM 110

The School of Design seeks to combine a sound education in the liberal arts with professional study that leads to careers in many fields of design. It offers the following degrees: B.F.A. in Communication Design; B.F.A. in Industrial Design; Master of Design in Interaction Design (with specializations in Human-Computer Interaction Design and Human-Machine Interaction Design); Master of Design in Communication Planning and Information Design (a joint degree with the Department of English); and Master in Product Development (a joint degree with the Department of Mechanical Engineering with support from the Tepper School of Business).

Drama Office: PCA 220

The School of Drama offers a highly focused, world-class theatre education with thorough preparation for sustained careers and innovation in today's widely-varied entertainment industries. The undergraduate programs lead to BFA degrees in Drama, with focuses in Acting, Music Theatre, Directing, Dramaturgy, Design, Production Technology and Management; MFA programs are offered in Scene, Costume, Sound, and Lighting Design; Directing; Dramatic Writing; and Production Technology and Management.

Music Office: CFA 105

The School of Music has as its goal the preparation of musicians for careers in performance, composition, conducting and teaching. The program provides the opportunity to study with world-class artists utilizing the best aspects of conservatory training in the context of a major research university, combining the educational with the intensely professional. Undergraduate degrees are offered in Music Composition and Music Performance with minors in Accompanying, Conducting, Jazz Performance, Music Education, and Music Technology available. The Master of Music is offered in Composition, Performance, Conducting and Music Education.

Bachelor of Humanities and Arts (BHA), Bachelor of Science and Arts (BSA), Bachelor of Computer Science and Arts (BCSA) Intercollege Degree Programs

Arin Blackford, Associate Director
Margaret Morrison Carnegie Hall, Room 107
www.cmu.edu/interdisciplinary

The Bachelor of Humanities and Arts (BHA) is a four-year intercollege degree-granting program designed for students interested in blending studies in the College of Fine Arts and the College of Humanities and Social Sciences. The BHA degree combines a General Education requirement, a concentration of courses in the College of Fine Arts, a concentration of courses in the College of Humanities and Social Sciences, and free electives. Please refer to Intercollege Programs in this catalog for details.

The Bachelor of Science and Arts (BSA) is a four-year intercollege degree-granting program designed for students interested in combining studies in the College of Fine Arts and the Mellon College of Science. It combines General Core requirements, a concentration of courses in the College of Fine Arts, a concentration of courses in the Mellon College of Science, and free electives. Please refer to Intercollege Programs in this catalog for details.

The Bachelor of Computer Science and Arts (BCSA) is a four-year intercollege degree-granting program designed for students interested in pursuing fields that comprehensively meld technology and the arts through courses offered in the College of Fine Arts and the School of Computer Science. It combines General Core requirements, a concentration of courses in the College of Fine Arts, a concentration of courses in the School of Computer Science, and free electives. Please refer to Intercollege Programs in this catalog for details.

The Master of Arts Management Program

1116 Hamburg Hall

The search for both increased support and larger audiences has intensified over the last decade and now, more than ever, arts organizations seek skilled managers. To meet this need, the College of Fine Arts and the Heinz School jointly developed the Master of Arts Management (MAM) Program to provide strong leadership in theater companies, dance companies, orchestras, opera companies, and visual arts organizations. In addition to the traditional two-year graduate degree structure, the Master of Arts Management Program provides undergraduate students the opportunity to complete the Bachelor of Fine Arts and Master of Arts Management degrees within a period of five years through the Heinz School's Accelerated Masters Program (AMP). MAM Program alumni can be found managing music and arts service organizations; marketing orchestras, theaters and dance companies; fund-raising for museums, opera companies, ballet companies and public television stations; and managing the finances of university arts departments and private businesses working in the arts and entertainment industry.

Student Defined Majors in the College of Fine Arts

To apply for a Student Defined Major in the College of Fine Arts, one:

1. Must be a student in good standing in the University and have completed at least one semester successfully.
2. Must have a cumulative QPA of 2.75 or better. A student whose QPA is under 2.75 may still submit a proposal. If the proposal is accepted by the Associate Deans, the student must apply for transitional status for the following semester and will have 1 semester to improve his or her QPA to the 2.75 minimum. If the student is not successful in raising the QPA to the 2.75 minimum, he or she may lose the affiliation with the current home department in the College of Fine Arts. If this happens the student must either be re-admitted back into the old program or seek admittance into another department or college.
3. Must have a statement of purpose that explains how and why the proposed course of study will be the best way for the student to receive an education and degree from Carnegie Mellon. This statement should detail the academic backbone of the program and project possible career paths after graduation.
4. Must outline the proposed courses to be taken and the semester in which they might be taken.
5. Must have a faculty mentor in the College of Fine Arts who has agreed to mentor the student through the completion of the degree. This mentor should be from the school where the student is taking the majority of his or her courses, and be approved by the Associate Deans.
6. Once the proposal has been submitted to the Associate Deans and they have reviewed it, the student will be required to go to the academic advisors in the school/schools where he or she will be taking courses and have them sign-off on the courses which are specific to their schools. Once the student has obtained all the necessary signatures, the completed proposal should be returned to CFA 100 for final review and approval by the Associate Deans.

All signed documentation should be submitted to the Office of the Dean of Fine Arts, CFA 100, by the first Monday in November in the fall semester, and by the last Monday in March in the spring semester. The proposal will be considered by the Associate Deans of the College, in consultation with the appropriate School Heads and Academic Advisors. Proposals that come in after these dates will be considered, but may not be able to be processed until the following semester. In that case, the student has the option to become a transitional student for a semester.

Under most circumstances the degree conferred at graduation will be a Bachelor of Arts. To continue in the program a student must

show academic progress toward the degree. The academic actions of the College will apply to all student-defined majors. The Office of the Dean, in consultation with the faculty mentor and academic advisor, will determine certification of the degree.

Student Organizations

Professional and honorary societies for students in the College of Fine Arts are the American Institute of Architects, Tau Sigma (honorary for students in architecture), Alpha Rho Chi (architectural award for leadership), the Student Design Forum (SDF), American Institute of Graphic Arts (AIGA), Industrial Designers Society of America (IDSA), United States Institute for Theatre Technology (USITT), Phi Mu Alpha Sinfonia (music fraternity for men), Sigma Alpha Iota (music sorority for women), Pi Kappa Lambda (honorary for students in music) and the Music Educators' National Conference.

Academic Standards

Grading Practices

Grades given to record academic performance in the College of Fine Arts are detailed on p. 48. All courses taught by the schools in the College of Fine Arts follow the standard letter grade system of the university. Responsibility for the grade given the student rests entirely with the instructor and the school concerned. A permanent grade may not be raised by taking a second examination. Students who wish to repeat a course already passed must obtain approval from the Dean of the College. At the time of approval, the Dean will decide in the light of circumstances whether the new grade or the old grade will be the official grade used as the computing factor for honors. Both grades, however, will appear on the official transcript.

Academic Actions

The decision to impose academic action is first initiated at the conclusion of each semester by the School faculty most involved in the student's primary area of study and then presented at the end of the semester to the Academic Actions sub-committee of the College Council for confirmation.

A student who is not making satisfactory progress toward meeting professional standards or toward completing graduation requirements in a School may have any of the academic actions listed below imposed by that School even though the student has received "passing" grades.

The academic actions listed below do not follow a particular sequence; any of the actions may be appropriately imposed at any time upon recommendation of the School faculty concerned and confirmation by the College Council.

Warning: For failure to maintain professional standards in a required course; or insufficient evidence of serious application to the professional standards of the School; or an overall quality point average below a satisfactory level. Warning action is intended to notify the student of unsatisfactory performance, and to suggest that the student take steps to determine and correct the cause of the difficulty.

Probation: For failure to pass any professional course as outlined by the faculty of the School; or failure to meet the professional standards of the School although no failing grades are given; or failure to earn the minimum quality point average required to continue in the School. A student on probation may be required to achieve a specified quality point average. The student must improve scholastic standing to an acceptable level in order to be removed from Probation. A student not doing so may be Suspended or Dropped at the end of the semester.

Final Probation: For significantly poor performance, or for continued failure to meet the professional standards of the School. The student must improve scholastic standing to an acceptable level in order to be removed from Final Probation. A student not doing so may be Suspended or Dropped at the end of the semester. This action may be taken without previous academic action.

School Suspension: For poor performance, or for personal problems that create an impediment to professional achievement in the School. A student is suspended from the School, but not the University, when it is deemed in the best interest of the student to allow continuation of study outside of the School during the period of the suspension. The student is not permitted to take courses in the School for a period to be determined by this faculty action, but will be re-admitted at the end of the period of School Suspension specified by the faculty after the condition of the School Suspension is satisfied.

Drop from the School: A student is Dropped from the School when it is clear that the student's progress in professional training is insufficient to warrant continuing in the current professional field of study in this College. This action is taken in the case of a student who has been lacking in some essential requirement in the chosen professional field, but whose general scholastic ability, habits and character justify an opportunity in some other field of education. This action terminates the student's enrollment in the current School, but is not intended to prejudice admission to another Department, School, or College of the University, or to another institution.

This academic action allows the student three choices:

- Transfer to another Carnegie Mellon University Department or School. A student must contact that Department or School of choice to discuss possible transfer.
- Request for Transitional status in the College of Fine Arts for one semester (see below: Transitional Students). A student must make an appointment with Lynna Martinez at the Carnegie Mellon Advising Resource Center in order to pursue this option.
- Withdraw from Carnegie Mellon University. An application for Withdrawal/Leave of Absence form is enclosed with the letter notifying a student of this academic action.

Drop from the College: A student is Dropped from the College when it is clear that the student shows no indication of being able to reach an acceptable level of performance or maintain steady progress toward completing graduation requirements. This action terminates the student's enrollment in the College of Fine Arts, but is not intended to prejudice admission to another College of the University, or to another institution.

This academic action allows the student three choices:

- Transfer to another Carnegie Mellon University College. A student must contact that College of choice to discuss possible transfer.
- Request for Transitional status in the College of Fine Arts for one semester (see below: Transitional Students). A student must make an appointment with Lynna Martinez at the Carnegie Mellon Advising Resource Center in order to pursue this option.
- Withdraw from Carnegie Mellon University. An application for Withdrawal/Leave of Absence form is enclosed with the letter notifying a student of this academic action.

A student who has been suspended from the University or has withdrawn is required to leave the campus, including residence halls and Greek houses, within a maximum of two days after the action and to remain off campus for the duration of the time specified. This action includes exclusion from part-time and summer study at the University for the duration of the period of the action.

Graduation Requirements

Because of the special nature of work in the College of Fine Arts, the first year in all schools should be considered probationary, a period in which a student and faculty can evaluate professional promise in terms of the college's standards. Graduation from the College of Fine Arts follows the general university guidelines. As part of a student's qualification for an undergraduate degree, the equivalent of two terms of full-time work must be pursued under the direction of faculty members in the college during the period immediately prior to the degree award. Courses completed at other institutions will not be acceptable as terminal credit for a degree. Exceptions to this stipulation can be recommended by a school faculty in unusual cases, but the concurrence of the College Council is necessary before final approval of an exception can be given.

Other graduation requirements in the College of Fine Arts are described in the curriculum of each school. Further questions about specific course requirements and the total number of units required should be directed to the respective school advisers.

Other Regulations Affecting Student Status

Schedule Changes

Courses may be added or dropped within the times stated in the college calendar. No courses may be added or dropped after the stated deadline dates except with the approval of the student's School Head and the Dean of the College. (See page 29 for Add/Drop procedures.)

Withdrawal/Leave of Absence

Please refer to the Student Leave Policy on page 50.

Transitional Students

The designation Transitional Student has been instituted by the Dean of the College of Fine Arts to assist students who have been judged unlikely to make satisfactory progress in their chosen professional field, or who on their own initiative, have changed their mind about their originally chosen field of study. Being a Transitional Student gives them an opportunity to maintain a relationship with the College of Fine Arts while re-orienting career plans and goals. It also gives them time to enhance their admissibility to another school in the college, another college in the university, or another institution. Ordinarily a student will be permitted to register as a Transitional Student for no more than one semester.

Transitional status is made available to students upon the advice of their advisers or upon their own request. A student must make an appointment with the Lynna Martinez in the Carnegie Mellon Advising Resource Center to discuss this option.

Transfer Students

Undergraduate students seeking transfer within or to any school of the College of Fine Arts must file an application with the School and proceed with the established transfer application procedure, audition, portfolio review or ASAT requirements. Admission may dictate freshman status regardless of the student's prior college experience.

Materials

The college does not furnish students with any drawing materials, make-up materials, textbooks, or other expendable equipment except those in courses in which materials fees are charged to cover specific costs.

Retention of Students' Work

The college reserves the right to retain indefinitely any student work the faculty may select. All work not retained by the faculty must be claimed at the time specified on the bulletin boards of the schools concerned. The college assumes no liability for student materials in its custody.

Minors Offered by the College of Fine Arts

The College of Fine Arts offers minors in Architecture, Art, Design, Drama, and Music to students from other colleges at Carnegie Mellon University. These minors allow students at Carnegie Mellon to take courses and develop a direction for electives in any of the five schools in CFA. Students in the College of Fine Arts may also earn minors outside of their major within other schools in the College. They may also study any of the minors offered by the other colleges to the University at large, thus taking advantage of the broad educational opportunities available at Carnegie Mellon University.

Minors Offered by the College of Fine Arts:

- Architecture
- Architectural History (available also to B. Arch candidates)
- Architectural Representation and Visualization
- Architectural Technology
- Art
- Building Science (available only to B. Arch candidates)
- Communication Design
- Drama
- History of the Arts
- Industrial Design
- Jazz Performance
- Music Performance
- Music Composition
- Music Technology
- Music Theory
- Photography

Guidelines for students are: 1) except where so designated, CFA students are not eligible to earn a minor in their own school; students from outside CFA may earn a minor in any school in CFA; 2) faculty advisers in the student's home school (in consultation with the academic officer of the other unit involved) will advise students as to the structuring of the courses in each minor; 3) a minor is not to be considered an overload; rather, through the assistance of faculty advisors it should be integrated into a student's overall units required for graduation; 4) the advisors will also monitor the student's development in these minors and keep records in their files which indicate the fulfillment of the course requirements in the minors, as well as in the majors in the student's own school. Courses listed as possible for the minors may be available, but not all courses are offered every semester. Students should consult with their advisors.

Students interested in earning a minor in any of the CFA schools should contact: Architecture: Heather Workinger; Art: Keni Jefferson; Design: Melissa Cicozi; Drama; Music: Lewis Strouse.

Minor in Architecture

This sequence is for candidates who intend to develop intellectual links to the architectural profession. The scope of courses offered includes a full spectrum of professional issues in architecture.

Prerequisite Courses 9 units

64-100	Critical Histories of the Arts	9
or		
79-104	Introduction to World History	9

Required Courses 18-21 units

48-100	Architecture Design Studio: Foundation I	12
or		
48-095	Architecture for Non-Majors*	9
48-240	Historical Survey of World Architecture and Urbanism	9

Elective Courses ** 27 units

48-130	Architectural Drawing I: A Tactile Foundation	6
48-135	Architectural Drawing II: Appearance	9
48-230	Architectural Drawing III: Perspective	9
48-210	Statics	9

48-215	Materials and Assemblies	9
48-217	Structures	9
48-xxx	Architecture History	9
48-351	Human Factors in Architecture	9
48-452	Real Estate Design and Development	9
48-453	Urban Design Theory and Practice	9
48-551	Ethics and Decision Making in Architecture	9
48-xxx	Architecture Elective	9

Minimum Units: 54

* Where students can demonstrate equivalent experience with design issues within other disciplines, for example in the School of Design, this requirement can be waived. However, this 12 unit requirement must then be replaced with another 12 units of elective coursework with the School.

**Students should consult the Architecture advisor regarding elective choices.

Minor in Architectural History (available also to B. Arch Candidates)

This sequence is intended for candidates interested in the history of architecture in its many manifestations, including high style and vernacular buildings, western and non-western traditions, built and theoretical works, and rural to urban contexts. Non-architecture majors are required to take 54 units of architectural history. Architecture majors wishing to minor in Architectural History must fulfill the three core required courses in architectural history, plus four additional architectural history electives, for a total of 63 units. Students wishing to pursue the minor should meet with the Architecture advisor to determine if a course is eligible.

Prerequisite Courses 18 units

64-100	Critical Histories of the Arts	9
or		
79-104	Introduction to World History	9
48-240	Historical Survey of World Architecture and Urbanism	9

Elective Courses 36 units/45 units

48-338	European Cities in the XIX Century	9
48-340	Modern Architecture and Theory, 1900-1945	9
48-341	History of Architectural Theory	9
48-343	American Built Environment Since 1860	9
48-344	Henry Hornbostel	9
48-345	The Cultural Landscape of Northern Italy	9
48-348	History of Central American Architecture	9
48-433	The Destruction and Rebuilding of Iconic Buildings and Cities	9
48-436	History of Architecture and the Body	9
48-440	American Regionalism	9
48-441	Frank Lloyd Wright	9
48-445	The City in History	9
48-447	History and Preservation	9

Minimum Units: 54 (non architecture majors)
Minimum Units: 63 (architecture majors)

Minor in Architectural Representation and Visualization

This sequence is for candidates who intend to develop particular skills in architectural representation.

Required Courses 30 units

48-120	Introduction to Digital Media I	6
48-130	Architectural Drawing I: A Tactile Foundation	6
48-135	Architectural Drawing II: Appearance	9
48-230	Architectural Drawing III: Perspective	9

Elective Courses 21 units

48-125	Introduction to Digital Media II	6
48-355	Drawing Architecture	9
48-477	Making Things Interactive	9
48-568	Advanced CAD, BIM, and 3D Visualization	9
48-576	Mapping Urbanism	9

Minimum Units: 51

Minor in Architectural Technology

This sequence is for candidates who intend to develop intellectual links to the technical aspects of the profession. It is not available to B. Arch Candidates.

Prerequisite Courses 14 - 22 units

21-114	Calculus for Architecture	5
or		
21-120	Differential and Integral Calculus	10
48-115	Physics for Architecture	9
or		
33-106	Physics for Engineering Students I	12

Elective Courses 32 - 40 units

48-210	Statics	9
48-215	Materials and Assemblies	9
48-217	Structures	9
48-315	Environment I: Climate and Energy	9
48-410	Environment II: Acoustics and Light	6
48-412	Environment III: Mechanical Systems	9
48-415	Advanced Building Systems	6
48-xxx	Architecture Elective	9

Minimum Units: 54

Minor in Building Science

(Available only to B. Arch Candidates)

This sequence is intended for candidates seeking in depth knowledge in the area of architectural science and for those interested in gaining advanced placement in the M.S. Program offered by the School of Architecture in Building Performance and Sustainable Design.

Required Courses 9 units

48-711	Research Models and Methods	9
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Elective Courses 45 units

48-596	LEED Building and Green Design	6-9
48-721	Building Controls and Diagnostics	12
48-722	Building Performance Modeling	12
48-723	Performance of Advanced Building Systems	9
48-729	Productivity, Health, and Quality of Buildings	9-12
48-728	Special Topics in BPD	9
48-749	Special Topics in CAD	9
48-752	Zero Energy House	9

Minimum Units: 54

Minor in Art

Concept Studio (choose one)		10 units
60-101	Concept Studio I: The Human Being (fall)	10
60-102	Concept Studio II: Time and Space (spring)	10
60-201	Concept Studio III: Systems and Processes (fall)	10

Media Studios (choose two)

60-110	Electronic Media Studio I: Computer Art (fall)	10
60-210	Electronic Media Studio II: Video Art (fall and spring)	10
60-130	Three Dimensional Media Studio I (spring)	10
60-230	Three-Dimensional Media Studio II (fall)	10
60-150	Two-Dimensional Media Studio I: Drawing (fall)	10
60-151	Two-Dimensional Media Studio II: Drawing (spring)	10
60-250	Two-Dimensional Media Studio III: Painting (fall and spring)	10
60-251	Two-Dimensional Media Studio IV: Printmaking (spring)	10

Advanced Media (choose two) 20 units

60-4xx	Advanced ETB: Electives	10
60-4xx	Advanced SIS: Electives	10
60-4xx	Advanced PDP: Electives	10

Art History/Theory 9 units

60-105	Pre-Industrial Visual Cultures 1789 (spring)	9
60-205	Modern Visual Cultures 1789-1945 (fall)	9
60-206	Contemporary Visual Cultures 1945 to the Present	9
60-3xx	Art History/Theory Electives	9

Minimum units: 59

Minor in the History of Arts

This minor of six or more courses as designated below, will offer students a grouping of Arts History courses that can provide a broad survey in the arts or a highly specialized field. For College of Fine Arts students, all courses meeting the requirements of the Minor in the History in the Arts must be taken outside of their major School, with the exception of the School of Architecture. Interested students should contact Jessica Garcia in the College of Fine Arts, Room 100.

Introductory Level Courses: 27 units (choose at least three, CFA students pick 3 outside of major)

48-240	Historical Survey of World Architecture and Urbanism (pre-requisite for all advanced architecture classes below)	9
51-271	Design History I: Fall Only	9
54-239	History of Architecture and Decor	6
54-245	History of Clothing: Fall	6
54-246	History of Clothing: Spring	6
57-173	Survey of Western Music History	9
60-205	Modern Visual Cultures 1789-1945 (fall)	9
60-206	Contemporary Visual Culture: 1945 to Present	9

Advanced Courses 27 units (choose at least three, CFA students pick 3 outside of major)

48-340	Modern Architecture and Theory, 1900-1945	9
48-341	History of Architectural Theory	9
48-343	American Built Environment Since 1860	9
48-344	Henry Hornbostel	9
48-345	The Cultural Landscape of Northern Italy	9
48-348	History of Central American Architecture	9
48-436	History of Architecture and the Body	9
48-440	American Regionalism	9
48-441	Frank Lloyd Wright	9
48-443	The Destruction and Rebuilding of Iconic Buildings and Cities	9
48-447	History & Preservation	9
51-272	Design History II (instructor permission only)	9
51-378	History of the Book and Printing (offered intermittently)	6
54-381	History of Drama: Fall	3
54-382	History of Drama II	3
57-202	Opera History (offered intermittently)	9
57-209	The Beatles	6
57-477	Music of the Spirit	6
57-478	Survey of Historical Recordings	6
57-480	History of Black American Music	6

60-350			
to 60-398	Art History/Theory Special Topics (instructor permission only)	9	
62-360/ 79-360	Photographers and Photography since WWII	9	
62-371/ 79-372	Photography, The First 100 Years	9	
79-324	Modern Painting (offered intermittently)	9	
79-355	The American Skyscraper: Its History and Development	6	
79-364	Art, Anthropology and Empire	9	
79-395	The Arts in Pittsburgh	9	
79-396	Music and Society in the 19th/20th Century Europe and the US	9	

minimum units required: 54

Minor in Communication Design

This program gives an overview of basic visual communication skills and the concerns of the communication design professions. Entry into the program and course registration is contingent upon your ability to demonstrate an acceptable level of design skills and aptitude through a portfolio review. Students must receive approval and course counseling for a Minor in Communication Design from the Communication Design Faculty Advisor before beginning the sequence of required courses. Through this advising system, a curriculum sequence will be chosen to meet your specific needs and fit within Design's current course capacities. Applications are reviewed each February.

Required Courses 18 units

51-261	Communication Design Fundamentals (fall or spring)	9
51-271	Design History I (fall)	9

Elective Courses 36 units

Elective courses are to be chosen from those listed in the current course catalog. This program description is based on the latest information at the time of publication. Interested students should contact the School of Design regarding any changes in the program and the availability of courses.

minimum units required: 54

Minor in Industrial Design

This program gives an overview of basic design skills and concerns of the product design profession. It is intended to enable students from Engineering, Humanities and Social Science, Management and other colleges to interact effectively with professional Product Designers. Entry into the program and course registration is contingent upon your ability to demonstrate an acceptable level of design skills and aptitude through a portfolio review. Students must receive approval and course counseling for a Minor in Industrial Design from the Industrial Design Faculty Advisor before beginning the sequence of required courses. Through this advising system, a curriculum sequence will be chosen to meet your specific needs and fit within Design's current course capacities. Applications are reviewed each February.

Required Courses: 18 units

51-263	Industrial Design Fundamentals (fall or spring)	9
51-271	Design History I (fall)	9

Elective Courses: 36 units

Elective courses are to be chosen from those listed in the current course catalog. This program description is based on the latest information at the time of publication. Interested students should contact the School of Design regarding any changes in the program and the availability of the courses.

minimum units required: 54

Minor in Drama

The Drama minor provides students with a well-rounded opportunity to obtain preliminary professional exposure to the theatre arts. Courses may involve acting, directing, playwriting, design, and a series of related Theatre History courses. Students also become involved with Drama productions by signing up for Production for Non-Majors, which involves evening crew work on various Drama productions.

Admission Requirements

1. Students must apply to enter the program in the office of the Drama Advisor, PCA 223.
2. The student must successfully pass one Drama course prior to being considered for minor status.

Required Courses	25 units
54-163/4	Production for Non-Majors (6+6 units)
54-177	Foundations of Drama I (6 units)
54-178	Foundations of Drama II (6 units)
54-175/6	Conservatory Hour (1 unit)
	(only one semester required)

Students must meet with the School of Drama Production Manager (PCA 224) for assignments related to Production for Non-Majors.

Elective Courses 30 units
The remainder of the minor is fulfilled with Drama courses of the student's choosing, with approval from the Academic Coordinator of the School of Drama. For certain courses, students may need instructor permission to register.

Elective Courses not requiring instructor permission:

54-187/8	Introduction to Playwriting	6
54-189/90	Advanced Playwriting	9
54-191/2	Acting for Non-Majors	9
54-193/4	Intro to Screenwriting	9
54-195/6	Advanced Screenwriting	9

Selected Elective Courses requiring instructor permission:

54-109	Dramaturgy I	9
54-121	Directing I	9
54-157	Basic PTM	6
54-169	Studiocraft I	6
54-171	Basic Design	6
54-330	Intro to Stage Management	6

Additional Drama Courses are available by instructor agreement and may require an audition, interview, or portfolio review. Students should contact the Drama Academic Coordinator to inquire about permission for specific courses in which they are interested.

Minimum units required: 55

Minor in Jazz Performance

This sequence is for candidates who are majors from any discipline in the university who have substantial potential as demonstrated by an acceptable audition and would like to improve their jazz performance skills.

Admission Requirements

1. The student must apply to enter the program in the office of the Director of Student Services (CFA 108).
2. The student must perform an acceptable audition. For the audition, the student should perform two contrasting pieces and demonstrate the potential for the development of improvisatory skills.

Prerequisite Courses	12 units	
57-090	Basic Theory Skills	0
57-092	Basic Solfege Skills	0
57-152	Harmony I	6
57-181	Solfege I	6

Required Jazz Courses	24 units	
57-xxx	Jazz Ensemble or Jazz Vocal Ensemble	3
57-xxx	Jazz Ensemble or Jazz Vocal Ensemble	3
57-319	Jazz Piano	3
57-320	Jazz Piano	3
57-328	Jazz Chamber Music	3
57-328	Jazz Chamber Music	3
57-450	Jazz Ear Training	3
57-453	Jazz Improvisation	3

Required Studio Courses 24 units
This requirement must be fulfilled by taking Minor Studio for 4 semesters.

Elective Courses (choose 1) 6 units

57-451	Jazz Arranging	6
57-452	Jazz Composition	6
57-454	Jazz Transcription and Analysis	6
57-457	Jazz History I	6
57-458	Jazz History II	6

Minimum units required: 54

Minor in Music Performance/ Music (Composition)

This sequence is for candidates who are majors from any discipline in the university other than music who have professional potential demonstrated by an acceptable audition and would like to improve their performance skills, but who have chosen to pursue a major other than music.

Admission Requirements

1. The student must apply to enter the program in the office of the Director of Student Services (CFA 108).
2. The student must perform an acceptable audition. Requirements for the audition can be found in the Admission section of the Undergraduate Catalog.

Prerequisite Course 3 units
Beginning Piano is required of students who do not pass a piano proficiency test.

57-103 Beginning Piano 3

Introductory Courses 22 units
57-161 Eurhythmics I 3
57-181 Solfege I 3
57-152 Harmony I 6
57-173 Survey of Western Music History 9
57-188 Repertoire and Listening for Musicians 1

Required Studio Courses 24 units
57-496 Minor Studio 6
57-497 Minor Studio 6
57-498 Minor Studio 6
57-499 Minor Studio 6

Elective Courses (for non-voice minors) 24 units
Elective courses are to be chosen from those course listed for the School of Music in the current course catalog. Performance electives are encouraged. (An audition is required for all School of Music Performance ensembles.)

Required Language Courses (for voice minors) 18 units

Language course (choose 1)
82-101 Elementary French I 12
82-121 Elementary German I 12
82-161 Elementary Italian I 12

Diction course (choose 1)
An introductory course in the applicable language is a prerequisite for each of these courses.

57-221 Italian Diction 3
57-222 French Diction 3
57-223 German Diction 3

literature and repertoire course (choose 1)
An introductory course in the applicable language is a prerequisite for each of these courses.

57-431 Italian Literature and Repertoire 3
57-432 French Literature and Repertoire 3
57-435 German Literature and Repertoire 3

other courses (choose 6 units)
These courses are to chosen from those courses listed for the School of Music in the current course catalog. Performance electives are encouraged. (An audition is required for all School of Music performance ensembles.) Additional diction, literature and repertoire, and language electives are encouraged for voice minors.

Minimum units required: 70

Minor in Music Technology

This sequence is for candidates who are music majors; art, design, or drama majors who are interested in recording, sound-editing and other music technology areas (in addition to courses in their home schools); or majors from any discipline in the university who have some background in music and would like to know more about music technology.

Admission Requirements

1. The student must apply to enter the program in the office of the Director of Student Services (CFA 108).

Prerequisite Course 3 units

Computing @ Carnegie Mellon must be passed before taking any of the required technology courses.

Introductory Music Courses 16 units
57-152 Harmony I 6
57-173 Survey of Western Music History 9
57-188 Repertoire and Listening for Musicians 1

Required Music Technology Courses 33 units
57-101 Introduction to Music Technology 6
57-337 Sound Recording 6
57-338 Sound Editing and Production 6
57-347 Electronic and Computer Music 6
57-438 MultiTrack Recording 9

Technical Courses (choose 2) 15 units
xx-xxx H&SS multimedia course 9
15-100 Introductory/Intermediate Programming 10
15-229 Multimedia Programming and Computer Science 9
33-114 Physics of Musical Sound 6
54-165 Sound Design I 6
57-610 Internship 9

Minimum units required: 64

Minor in Music Theory

This sequence is for candidates who are majors from any discipline in the university other than music who have some background in music and would like to know more about music theory.

Admission Requirements

The student must apply to enter the program in the office of the Director of Student Services (CFA 108).

Prerequisite Courses 3 units

Beginning Piano is required of students who do not pass a piano proficiency test.

57-103 Beginning Piano 3

Introductory Courses 22 units
57-152 Harmony I 6
57-161 Eurhythmics I 3
57-173 Survey of Western Music History 9
57-188 Repertoire and Listening for Musicians 1
57-181 Solfege I 3

Required Theory Courses 27 units
57-151 Principles of Counterpoint 6
57-153 Harmony II 6
57-257 Orchestration I 6
57-408 Form and Analysis 6
57-612 Independent Study in Music Theory 3

Analysis Course 6 units

Other analysis courses may also be approved by the advisor for music minors.

57-442 Analytical Techniques 6

Minimum units required: 55

Minor in Photography

The Photography Minor exposes students to the breadth of photography offering experiences in traditional photography (i.e. film exposure and silver printing) to digital shooting and output. The student who takes the Photography Minor will become familiar with photography's craft, its history and significant practitioners, and develop his/her own distinct engagement with the medium.

Students may apply for the Photography Minor after they have taken a CFA or Pittsburgh Filmmakers' beginning photography course. Freshmen should not apply for the minor. Students in four-year undergraduate programs may apply in their sophomore or junior year. Students in five-year undergraduate programs, such as Architecture, may apply in their second, third, or fourth year. Applications are accepted in both the fall and spring semesters. Students will be admitted to the minor based on their aptitude, appropriate level of photography skills, and space availability within the program. Once admitted, students will be assigned a faculty advisor who will help them determine a sequence of courses that best fits their needs and interests.

Application requirements

The application process for the Photography Minor requires submission of: a completed application form signed by the home department advisor, a personal statement, and a portfolio of photographs. Contact the CFA Photography Administrator, Jamie Gruzka, MM B18, for further information and an application form.

Photography Required Courses (3) 27 units

62-141/ 60-141/ 51-265; or Black & White Photography I * **	9 units
62-241 Black & White Photography II	9 units
62-381 Color Photography and Digital Output	9 units

Photography Elective (1) 9 units

Choose one (1) additional photography course from the list below in consultation with the photo advisor, or consult Jamie Gruzka for current offerings. Also, photo courses may be taken at Pittsburgh Filmmakers. Please refer to their course catalog that is available in the CFA Dean's Office, CFA 100, or online: pghfilmmakers.org

51-338 Documentary Photography
62-245 Portrait Photography
62-265 Alternative Photo Processes
62-337 Studio Lighting
62-325 View Camera
62-372/51-330 Photo Book

Photo History Required Course (1) 9 units

62-371 Photography, The First 100 Years **	9 units
or	
62-360 Photography Since World War II **	9 units

History, Theory, or Criticism of the Visual Arts Elective (1) 9 units

Choose one (1) additional History, Theory or Criticism of the Arts course in consultation with the photo advisor. A second Photo History course (62-360 or 62-371) can be used for this requirement.

* prerequisite for photo courses other than history, theory, and/or criticism course

** or course approved by the photography advisor

Minimum units required: 54

School of Architecture

Stephen R. Lee, AIA, LEED AP, Interim Head
Office: CFA 201

The mission of the School of Architecture is to educate outstanding professionals with design creativity, social responsibility, global environmental vision, historical perspective, and technical excellence. Our comprehensive curriculum and the accomplishments of our expert faculty fully reflect this dedication.

Bachelor of Architecture Program

The Bachelor of Architecture Program is five years in length and is fully accredited by the National Architectural Accrediting Board (NAAB)*. The program provides preparation for a required architectural internship, then entry into the practice of architecture. The curriculum consists of courses centered around an Integrated Design Studio Sequence with foci in seven areas: Integrated Architectural Design Studios, Fundamental University Courses and Electives, History, Drawing and Digital Media, Building Technology, Environmental Technology, and Professional Practice. All required courses in the first two years must be taken and passed before a student may enter the third year. A minimum of 494 units is required for graduation.

*In the United States, most registration boards require a degree from an accredited professional degree program as a prerequisite for licensure. The National Architectural Accrediting Board (NAAB) which is the sole agency authorized to accredit US professional degree programs in architecture, recognizes two types of degrees: the Bachelor of Architecture and the Master of Architecture and the Doctor of Architecture. A program may be granted a six-year, three-year, or two-year term of accreditation, depending on its degree of conformance with the established educational standards. Masters degree programs may consist of a pre-professional undergraduate degree and a professional graduate degree, that when earned sequentially, constitute an accredited professional education. However, the pre-professional degree is not, by itself, recognized as an accredited degree. (National Architecture Accrediting Board Conditions and Procedures 2004)

Curriculum

First Year

	Fall	Units
48-100	Architecture Design Studio: Foundation I	12
48-120	Introduction to Digital Media I	9
48-130	Architectural Drawing I: A Tactile Foundation	6
21-114	Calculus for Architecture (mini 2)	5
64-100	Critical Histories of the Arts	9
or		
76-101	Interpretation and Argument	9
99-101x	Computing @ Carnegie Mellon	3
		44

	Spring	Units
48-105	Architecture Design Studio: Foundation II	12
48-115	Physics for Architecture	9
48-125	Introduction to Digital Media II	6
48-135	Architectural Drawing II: Appearance	9
76-101	Interpretation and Argument	9
or		
64-100	Critical Histories of the Arts	9
		45

Second Year

	Fall	Units
48-200	Architecture Design Studio: Composition	18
48-210	Statics	9
48-230	Architectural Drawing III: Perspective	9
48-240	Architecture History I: Historical Survey of World Architecture and Urbanism	9
xx-xxx	University Elective	9
		54

	Spring	Units
48-205	Architecture Design Studio: Materials	18
48-215	Materials and Assemblies	9
48-217	Structures	9
48-xxx	Architecture Elective	9
xx-xxx	University Elective	9
		54

Third Year

	Fall	Units
48-300	Architecture Design Studio: Site	18
48-312	Site Engineering and Foundations	6
48-315	Environment I: Climate and Energy	9
48-xxx	Architectural History II	9
xx-xxx	University Elective	9
		51

	Spring	Units
48-305	Architecture Design Studio: Advanced Construction	18
48-351	Human Factors in Architecture	9
48-xxx	Architectural History III	9
48-xxx	Architecture Elective	9
xx-xxx	University Elective	9
		54

Fourth Year

	Fall	Units
48-400	Architecture Design Studio: Occupancy	18
48-410	Environment II: Acoustics and Light	6
48-412	Environment III: Mechanical Systems	9
48-452	Real Estate Design and Development	9
48-xxx	Architecture Elective	9
		51

	Spring	Units
48-405	Architecture Design Studio: Systems Integration	18
48-415	Advanced Building Systems	6
48-xxx	Architecture Elective	9
xx-xxx	University Elective	9
xx-xxx	University Elective	9
		51

Fifth Year

	Fall	Units
48-500	Architecture Design Studio: The Urban Lab	18
48-497	Thesis Preparation (optional)	3
48-550	Issues of Practice	9
48-453	Urban Design Theory and Practice	9
48-xxx	Architecture Elective	9
		48

	Spring	Units
48-505	Studio X	18
48-551	Ethics and Decision Making in Architecture	9
48-xxx	Architecture Elective	9
xx-xxx	University Elective	9
		45

Fundamental University Courses

(4 lecture courses)

A significant set of university courses in mathematics, physical sciences, social sciences, writing, and history are prerequisite to the School's own offerings. Beyond the preparation in fundamentals that these courses provide, this early emphasis upon core university course work allows for transfer to other departments within the College and University following the first several semesters of the student's studies.

21-114	Calculus for Architecture
64-100	Critical Histories of the Arts
76-101	Interpretation and Argument
99-10x	Computing @ Carnegie Mellon

Integrated Design Studios

(10 Studios)

Architectural design studios compose the core of the undergraduate curriculum. The ten studios are organized around a sequence of semester topics that are the focus of the design projects. In sequence, these topics are: form, space, composition, materials, site construction, occupancy, systems integration, and urban design. Studio X is intended to allow for study abroad, thesis,

or interdisciplinary studies. As an integrated sequence, requisite courses work in conjunction with specific studios to provide students with the necessary knowledge base to successfully resolve their design projects. Design studios are taught using a team approach, with a common lecture series and a set of related exercises for each studio level. Faculty members are practicing architects, scholars, as well as academic researchers bringing a diverse set of perspectives to the studio environment. Studio spaces are provided to all students, with the first, second and third year studios located in Margaret Morrison Hall. Fourth and fifth year studios are located on the second floor of the College of Fine Arts Building. Studios provide a faculty to student ratio of 1:12.

48-100	Architecture Design Studio: Foundation I
48-105	Architecture Design Studio: Foundation II
48-200	Architecture Design Studio: Composition
48-205	Architecture Design Studio: Materials
48-300	Architecture Design Studio: Site
48-305	Architecture Design Studio: Advanced Construction
48-400	Architecture Design Studio: Occupancy
48-405	Architecture Design Studio: Systems Integration
48-500	Architecture Design Studio: The Urban Lab
48-505	Studio X

History (1+3 courses)

In addition to Critical Histories of the Arts, taken during the first year, three core courses in architectural history are required for the Bachelor of Architecture degree. All second year students must complete the Historical Survey of World Architecture & Urbanism, which focuses on the major monuments of western civilization, as well as highlighting non-western and vernacular traditions. Two additional core courses on the history of architecture are required. These two courses must be taken within the School of Architecture and must have been designated as satisfying the core requirements. The core architectural history courses consider more specific topics and are intended to provide students with advanced skills in investigating architecture from the historical perspectives of culture, society, politics, religion, economics, theory, and/or technology. These courses are also intended to develop research and writing skills. It is highly recommended that the two additional core history requirements be completed prior to the fifth year.

In addition to the three core architectural history courses, elective courses on additional topics of architectural history may also be taken. With approval of the specific electives, students completing four additional nine-unit architectural history and theory courses beyond the three required may graduate with a minor in Architectural History.

64-100	Critical Histories of the Arts
48-240	Architectural History I: Historical Survey of World Architecture and Urbanism
48-xxx	Architectural History
48-xxx	Architectural History

Drawing and Media (5 courses)

Drawing and modeling both by hand and with the computer are core skills for developing powers of observation, the ability to think in three dimensions, and are fundamental in communicating architectural ideas. Computational skills, including the use of programs specializing in digital representation, in combination with traditional skills of representation are stressed in courses throughout the curriculum.

Drawing, media representation, and model making are primary topics of both first year studios and are associated with five other specific courses: Introduction to Digital Media I and II, Architectural Drawing I and II in the first year, and Architectural Drawing III in the second year. Thereafter students may elect to take further drawing and media courses during years three, four and five in fulfillment of the school elective requirements.

48-120	Introduction to Digital Media I
48-125	Introduction to Digital Media II
48-130	Architectural Drawing I: A Tactile Foundation
48-135	Architectural Drawing II: Understanding Appearance
48-230	Architectural Drawing III: Perspective

Technology: Building, Materials, and Structures (5 courses)

The School sees technical knowledge as design knowledge and places major emphasis on understanding the state-of-the-art and major innovations in building structure, enclosure, mechanical, lighting, and interior systems. The goal of the Structures and Building sequence is to offer a rigorous introduction to science fundamentals, to provide a systematic and comprehensive introduction into the major fields of building science and technology, and to provide a solid technical foundation both for architectural

design studios and for more advanced subsequent science and technology electives. Courses build one upon the other and provide technical knowledge for application in the design studio as well as providing foundations for more in-depth study and minors in associated fields.

48-115	Physics for Architecture
48-210	Statics
48-215	Materials and Assemblies
48-217	Structures
48-312	Site Engineering and Foundations

Technology: Environment/Sustainability (4 courses)

The School sets environmental education as one of its highest priorities. The goal of this sequence is to provide a thorough foundation of technical knowledge coupled with a creative design inquiry, which allows students to effectively address serious environmental challenges. The courses address issues raised by concerns over the ecological responsiveness of buildings to context, energy effectiveness, and healthy building design for global environmental sustainability while considering the opportunities of human differences related to the psychology of the individual, the sociology of groups, ergonomics, ADA codes & standards and indoor environmental quality including acoustic, visual, air and thermal quality of spaces designed for human habitation.

48-315	Environment I: Climate and Energy
48-410	Environment II: Acoustics and Light
48-412	Environment III: Mechanical Systems
48-415	Advanced Building Systems

Professional Practice, Ethics, Management (5 courses)

Architecture is a multifaceted field of practice, existing within dynamic social, organizational, economic, professional, and cognitive contexts. The goal of this sequence is to educate design professionals with expertise in: programming and diverse design decision making processes, multi-disciplinary team design processes, methods of professional practice in urban design and architecture, management and documentation, facilities management including field diagnostics and post occupancy evaluation, real property management and overriding questions of ethics in practice.

48-315	Human Factors in Architecture
48-452	Real Estate Design and Development
48-453	Urban Design Theory and Practice
48-550	Issues of Practice
48-551	Ethics and Decision Making in Architecture

School Electives (6 Courses)

A minimum of six school electives is required for the Bachelor of Architecture degree. The general goal of the school electives is to build knowledge of architecture within the broad context of society; specifically, in light of economic, social, technological, political, and cultural forces. A more specific goal is to build in-depth knowledge and skill in an area of interest to the student.

University Electives (7 courses)

The school considers elective courses to be crucial for the intellectual breadth of an architect as a citizen in contemporary society. In this spirit, the School urges its students to use these courses as an opportunity to take advantage of the unique strengths of Carnegie Mellon University and to develop ties to other disciplines.

Dual Degrees

Students in the School of Architecture can pursue a dual degree program in the Tepper School of Business' undergraduate business program, Engineering at Carnegie Institute of Technology (CIT), History in Humanities & Social Sciences (H&SS), and Industrial Design in the School of Design. Other dual degree programs are possible and encouraged.

Minors in Other Disciplines

Minors may be earned in many of the Departments or Schools on campus. Generally, a student must take six courses within a specific department or concentration to receive a minor. Students interested in minors must contact the school or department of interest to determine specific requirements or prerequisites. Since students of architecture are required to take seven electives in other departments, students can easily complete a minor without adding additional coursework to their curriculum

Minors in Architecture

Undergraduate students in architecture can also qualify to earn two minors within the subject of architecture. These are the Minor in Architectural History and the Minor in Building Science. The Minor in Architectural History is intended for those candidates who want particular depth in this area. It is earned by applying all three school electives and four university electives to courses in architectural history. The Minor in Building Science is intended for those degree candidates seeking in depth knowledge in the area of architectural science and for those who are interested in gaining advanced placement in the M.S. programs offered by the School in the areas of Building Performance and Sustainable Design.

5 + 1 Masters Degree Options

The School of Architecture offers a unique opportunity to undergraduate students who wish to pursue a Masters degree in an architecture-related field. Undergraduate students may begin taking graduate-level courses in their 4th and 5th year of study. This allows students to graduate with a Masters degree in only one additional year of study beyond their 5-year undergraduate program.

Masters of Science in Computational Design

The Master of Science (MS) program in Computational Design is designed primarily for practitioners in the building industry who wish to broaden their knowledge about state-of-the-art computer approaches and applications to the architectural and building sciences and for individuals who wish to pursue research careers in these areas. The program covers, in depth, a range of computational design issues and culminates with a project in which students are asked to apply the knowledge they have acquired to realistic problems.

Masters of Science in Building Performance and Diagnostics

The Master of Science (MS) program specialized in Building Performance and Diagnostics is intended for practitioners, researchers and educators in architecture and the building industry who wish to be leaders in advanced building technologies and their performance. The program covers, in depth, knowledge concerning state-of-the-art approaches to building systems integration and total building performance. The program culminates with a project in which students must apply the knowledge they have acquired to realistic problems, using the appropriate analytical and modeling skills.

Masters of Urban Design

The 12-month post-professional Masters of Urban Design program prepares graduates for careers using design to address environmental, economic, social, and cultural issues affecting the contemporary metropolis critically. Studios explore strategies for sustainable development in a variety of settings including the shrinking postindustrial city, the suburban periphery, and the rapidly urbanizing region. Pittsburgh-based studios emphasize citizen engagement and participatory design, exploring problems of urban neighborhood revitalization, infrastructure development and suburban transformation, in partnership with the Remaking Cities Institute. The capstone studio, which includes a research trip, explores issues of sustainability in the context of an international city undergoing growth. The studio sequence is supported by core courses in urban history and theory, geographic analysis, sustainable community development and real estate.

Masters of Science of Tangible Interaction Design

The Master of Tangible Interaction Design (mTID) is designed primarily for those with a background to acquire the technical skills to realize embedded computing designs, and those with computer science and engineering backgrounds to apply their knowledge in design. The program includes coursework in software, electronics, and fabrication techniques for building working prototypes of tangible embedded interactive systems.

Masters of Science in Sustainable Design

The M.S. in Sustainable Design program builds on the expertise within our world-renowned research center, the Center for Building Performance and Diagnostics, to provide an integrated education intended to prepare its graduates for careers that will reshape the built environment in a sustainable fashion. The program addresses

the cross-disciplinary nature of sustainable design and is designed to meet the unique needs of those with prior experience in design and construction fields such as architecture, landscape architecture, engineering, construction, project design, and ecology. The program culminates with a project in which students must apply the knowledge they have acquired to realistic problems, using the appropriate analytical and modeling skills.

Masters of Science in Architecture-Engineering Construction Management

The Masters of Science (MS) program in Architecture-Engineering Construction Management is offered jointly with the Department of Civil Engineering and aims to prepare building delivery professionals – civil engineers, construction planners, facility managers, developers, architects, planners, landscape architects, interior designers, and other building consultants for careers in the management of design, construction, maintenance, and use of facilities. By focusing on the decision making process, the program educates professional in ways to positively impact economic, environmental, and ethical concerns inherent in the delivery of construction projects.

Student Advising

At the end of every semester, the faculty reviews each student's progress in all courses. Reviews during the first year are intended to determine a student's capabilities in relation to the study of architecture at Carnegie Mellon University, and the School works with each student to ensure placement within the university if a change is desired. Subsequent reviews monitor and ensure continued progress in all sequences of the program.

Students are urged to meet with the Senior Academic Advisor to review their academic progress and plans before each semester. Such meetings are important to take full advantage of elective possibilities within the curriculum, but they are equally important as an opportunity for discussion of long-term career goals. It is the policy of the School of Architecture that no student with a QPA below 3.0 from the previous semester will be permitted to overload. Students should also check their progress using the online academic audit (<https://acis.as.cmu.edu/gale2/audit/degreeaudit.html>)

Scholarships and Awards

The School of Architecture provides a number of scholarship and traveling fellowship opportunities to outstanding students. These opportunities include: Stewart L. Brown Award, Gindroz Prize, Ferguson Jacobs Prize in Architecture, Perkins Eastman Shanghai Summer Internship, Myres & Lubetz Internship Fund, and the Lewis Altenhoff Award.

Students who are eligible to participate in the School's Fourth-Year Design Awards Competition have the opportunity to compete for the following six prizes: John Knox Shear Memorial Traveling Scholarship, Louis F. Valentour Traveling Scholarship Fund, Richard M. Gensert Memorial Scholarship, and the Jan P. Junge Memorial Scholarship.

Study Abroad and Summer Abroad Program

The School of Architecture conducts an officially recognized exchange program for fourth year students to study abroad at: the EPFL in Lausanne, Switzerland; ITESM in Monterrey, Mexico; the National University of Singapore and the Henry van de Velde Institute in Antwerp, Belgium. Students are welcome to seek out other study abroad opportunities where course work is equivalent to studies at CMU to a maximum of 45 transfer units per semester. Students present study abroad plans to the School for review at the beginning of the third year. To receive credit for courses taken abroad, the student must have a C or better (not C-) in the course and have an official translated transcript sent to the School of Architecture. Studio work conducted abroad must be presented to the School Head and Studio Coordinator for approval.

In addition, the School offers a study-abroad program each summer. The locations of these programs vary from year to year. Recent offerings have included the Czech Republic, Austria, the Netherlands, China, Rome, Barcelona, and the Middle East. Students entering their fourth and fifth years of the Bachelor of Architecture program are eligible to apply.

Summer Courses

Students can receive credit for passing comparable courses at other institutions with advanced approval from the School. A Transfer Credit Evaluation form must be completed prior to enrollment at the other institution for a course to be considered for transfer.

Faculty

OMER AKIN, RA, Professor — PhD, Carnegie Mellon University; Carnegie Mellon 1973 —

DAVID ARCHER, CBPD Engineering Consultant — PhD; Carnegie Mellon 1991 —

MARYLOU ARSCOTT, RIBA, Adjunct Associate Professor; Carnegie Mellon 2007 —

MARTIN AURAND, Sr. Architecture Librarian/Archivist — MLIS, University of Pittsburgh; Carnegie Mellon 1987 —

AZIZAN AZIZ, Senior Researcher, CBPD — MS Building Performance & Diagnostics, Carnegie Mellon University; Carnegie Mellon 1997 —

WALTER BOYKOWYCZ, AIA, Adjunct Professor — MArch, Carnegie Mellon University; Carnegie Mellon 1969 —

TERESA BUCCO, RA, Adjunct Assistant Professor — MArch, North Carolina State University; Carnegie Mellon 2002 —

LEE CALISTI, AIA, Adjunct Assistant Professor — BArch, Kent State University; Carnegie Mellon 2002 —

JOE COOHILL, Adjunct Assistant Professor — PhD, Oxford; Carnegie Mellon 2007 —

DOUG COOPER, Andrew Mellon Professor — BArch, Carnegie Mellon University; Carnegie Mellon 1976 —

DALE CLIFFORD, Assistant Professor Gerard Damiani, AIA, Adjunct Professor of Practice — BArch, Syracuse University ; Carnegie Mellon 1996 —

GERARD DAMIANI, AIA, Adjunct Professor of Practice— BArch, Syracuse University ; Carnegie Mellon 1996 —

JEFFREY DAVIS, AIA, Adjunct Associate Professor — BS Architecture, University of Illinois, Urbana-Champaign; Carnegie Mellon 1996 —

KEN DOYNO, AIA, Adjunct Associate Professor — BArch, Carnegie Mellon University; Carnegie Mellon 1991 —

SARAH DRAKE, AIA, Adjunct Assistant Professor — MArch, North Carolina State University; Carnegie Mellon 2003 —

JOHN EBERHARD, Professor Emeritus, — M.S., Industrial Management, Massachusetts Institute of Technology; Carnegie Mellon 1989 —

JEREMY FICCA, AIA, Assistant Professor — MArch, Harvard; Carnegie Mellon 2007 —

MATT FINEOUT, AIA, Adjunct Associate Professor — MArch, Southern California Institute of Architecture ; Carnegie Mellon 2001 —

ERIC FISHER, AIA, Adjunct Assistant Professor — MArch, Harvard; Carnegie Mellon 2001 —

JOHN FOLAN, T. Fitzgibbon Visiting Professor 2008— MArch, University of Pennsylvania; Carnegie Mellon 2008 —

PABLO GARCIA, Assistant Professor — MArch, Princeton; Carnegie Mellon 2008 —

KEVIN GANNON, AIA, Adjunct Associate Professor — MArch, Yale; Carnegie Mellon 1996 —

MARK GROSS, Professor — PhD, MIT; Carnegie Mellon 2004 —

KAI GUTSCHOW, Associate Professor — PhD, Columbia; Carnegie Mellon 1998 —

VOLKER HARTKOPF, Professor, Director CBPD — PhD, University of Stuttgart; Carnegie Mellon 1972 —

DELBERT HIGHLANDS, Professor Emeritus — MArch, Carnegie Mellon University; Carnegie Mellon 1985 —

ERIK HOKANSON, AIA, Adjunct Assistant Professor — BArch, Kansas State University; Carnegie Mellon 2006 —

KELLY HUTZELL, Assistant Teaching Professor — MS Architecture and Urban Design, Columbia; Carnegie Mellon 2005 —

JEFFREY KING, AIA, Adjunct Assistant Professor — MArch, Tulane; Carnegie Mellon 2004 —

JONATHAN KLINE, Adjunct Assistant Professor — MFA, Penn State University; Carnegie Mellon 2002 —

RAMESH KRISHNAMURTI, Professor — PhD; Carnegie Mellon 1989 —

KRISTEN KURLAND, Teaching Professor — BArch, University of Pittsburgh; Carnegie Mellon 1996 —

KHEE POH LAM, RIBA, Professor — PhD, Carnegie Mellon University; Carnegie Mellon 2003 —

STEPHEN LEE, AIA, Interim Head — MArch, Carnegie Mellon University; Carnegie Mellon 1985 —

LAURA LEE, Professor, — MArch, University of Michigan; Carnegie Mellon 1989 —

DAVID LEWIS, Teaching Professor Emeritus; Carnegie Mellon —

CINDY LIMAURO, Professor, Drama — MFA in Lighting Design, Florida State University; Carnegie Mellon 1987 —

VIVIAN LOFTNESS, FAIA, University Professor — MArch, MIT; Carnegie Mellon 1981 —

ARTHUR LUBETZ, AIA, Adjunct Professor — BArch, Carnegie Mellon University; Carnegie Mellon 1988 —

JENNIFER LUCCHINO, AIA, Adjunct Assistant Professor — MArch, Rice University; Carnegie Mellon 2003 —

DUTCH MACDONALD, AIA, Adjunct Assistant Professor — BArch, Carnegie Mellon University; Carnegie Mellon 2006 —

GERRY MATTERN, P Eng, Adjunct Professor; Carnegie Mellon 1982 —

CHRISTINE MONDOR, AIA, Associate Professor in Practice — BArch, Carnegie Mellon University; Carnegie Mellon 1999 —

JASON MORRIS, AIA, Adjunct Assistant Professor — MArch, IIT; Carnegie Mellon 2005 —

IRVING OPPENHEIM, P Eng, Professor — PhD, Cambridge; Carnegie Mellon 1972 —

MARK PASNICK, Caste Visiting Assistant Professor 2008— MDesS, Harvard University; Carnegie Mellon —

MATTHEW PLECITY, RLA, Adjunct Assistant Professor — MArch , Virginia Tech; Carnegie Mellon 2006 —

ROBERT REID, P Eng, Adjunct Assistant Professor — PhD, Carnegie Mellon University; Carnegie Mellon 1987 —

LUIS RICO-GUTIERREZ, Director, Remaking Cities Institute — MS Building Performance, Carnegie Mellon University; Carnegie Mellon 2001 —

PAUL ROSENBLATT, AIA, Adjunct Associate Professor — MArch, Yale; Carnegie Mellon 1987 —

CHARLES ROSENBLUM, Adjunct Assistant Professor — , University of Virginia; Carnegie Mellon 2000 —

DAN ROTHSCHILD, AIA, Adjunct Associate Professor — MArch, Yale; Carnegie Mellon 2003 —

RAMI EL SAMAHY, Assistant Teaching Professor — MArch, Harvard University; Carnegie Mellon 2006 —

DIANE SHAW, Associate Professor — PhD, University of California - Berkeley; Carnegie Mellon 1996 —

SCOTT SMITH, Director, Architecture Shop — MFA, Cranbrook; Carnegie Mellon 1984 —

KENT SUHRBIER, AIA, Adjunct Assistant Professor — BArch, Carnegie Mellon University; Carnegie Mellon 2000 —

FRANCESCA TORELLO, Adjunct Assistant Professor — PhD, Politecnico Torino; Carnegie Mellon 2007 —

SPIKE WOLFF, Adjunct Assistant Professor — MArch, SCI-Arc; Carnegie Mellon 2003 —

RESEARCHERS

DAVID ARCHER, CBPD Engineering Consultant — PhD; Carnegie Mellon 1991 —

AZIZAN AZIZ, Senior Researcher, CBPD — MS Building Performance & Diagnostics, Carnegie Mellon University; Carnegie Mellon 1997 —

School of Art

John Carson, Head
Office: College of Fine Arts 300
<http://www.art.cfa.cmu.edu>

The university-based undergraduate program offered by the School of Art is designed to develop individuals capable of working as artists in a complex, rapidly changing global culture. The program incorporates an expansive approach to art and acknowledges that "working as artists" leads toward a wide variety of pursuits.

Admission to the undergraduate program is highly competitive. Students must show promise of excellence in both academic and artistic performance. Evidence of creative leadership is a plus.

The art faculty, all practicing artists or scholars, provide an intense, professional learning environment in which students develop close ties with their instructors and each other.

Art students are encouraged to take full advantage of the university environment through exposure to faculty and students in other departments in the College of Fine Arts and throughout the University. They are also encouraged to participate in the numerous cultural opportunities on campus and in the larger Pittsburgh community.

The School of Art maintains extensive contemporary studios to make possible its wide range of media offerings. It occupies the top two floors of the College of Fine Arts building, as well as a significant portion of Doherty Hall. Numerous exhibition venues inform or present student work including the Ellis Gallery, the University Center Gallery, The Miller Gallery, and the Frame Gallery, which is managed entirely by students.

The progressive curriculum requires that students attain high levels of knowledge, skill and commitment. The four-year undergraduate program offers one degree, the Bachelor of Fine Arts (B.F.A.) in Art. The School of Art is a charter member of the National Association of Schools of Art and Design (NASAD) and is fully accredited by this organization.

Using five categories of courses, the curriculum presents art-making in a unique manner which respects tradition and encourages innovation. The course categories are:

- I. Concept Studios
- II. Media Studios
- III. Advanced Studios
- IV. Academic Art Courses
- V. University Academic Courses

Studio courses comprise over sixty percent of the course of study and academic courses comprise the remainder. The division of the studio curriculum into conceptually-driven and media-driven courses acknowledges that neither concept nor media can be presented independently of one another. This curriculum ensures that all students experience high-quality, consistent training in a variety of approaches.

I. Concept Studios

The Concept Studios are the core of the art curriculum. Students are required to complete six concept studios, but may enroll in additional semesters. In the second semesters of the sophomore and junior years, Concept Studios are optional. Experiences gained in the other four components of the program are integrated into Concept Studios. Themes and topics addressed in Concept Studios include: the self and the human being, space/time, systems/processes, contextual practice, and senior project.

Freshman and sophomore Concept Studios are organized around structured assignments designed to assist the student in developing a personal, non-medium-specific approach to generating art as well as in learning transferable conceptual skills. The progression from semester to semester leads toward increasing complexity and independence. In the junior year, the Contextual Practice Studio is devoted entirely to context-related issues and art that engages a variety of communities. In the senior year, the Concept Studios, titled Senior Project, are devoted to a single student-generated body of work.

II. Media Studios

The Media Studios can be viewed as the foundation courses for the program. Students take two Media Studios each semester during the freshman and sophomore years for a total of eight courses. These studios ensure that all students have an exploratory experience with all of the media resources of the school. They also serve as preparation for advanced studio work.

Two-Dimensional Media Studios introduce drawing during the freshman year, and painting and printmaking during the sophomore year. Electronic Media Studios introduce computer-related work during the freshman year, and video in the sophomore year. Three-Dimensional Media Studios introduce ceramics, welding and wood during the freshman year, and foundry, metals, and mixed media during the sophomore year.

III. Advanced Studios

Students take a total of eight Advanced Studio elective courses during the junior and senior years. These courses address specialized studio work in one of the four artistic concentration areas in the school, which are:

- Painting, Drawing, and Printmaking (PDP)
- Sculpture, Installation, and Site Work (SIS)
- Electronic and Time-Based Work (ETB)
- Contextual Practice (CP)

A minimum of four courses must be taken in one of these concentration areas. One of the eight Advanced Studio courses must be a College of Fine Arts interdisciplinary course or in one of the Schools outside of Art: Architecture, Design, Drama, Music.

IV. Academic Art Courses

First-semester freshmen are required to take Contemporary Issues Forum, an introduction to current practices in the visual arts. A three-semester art history/theory survey sequence is then required of all students:

Freshman Year (spring):	Critical Histories of the Arts
Sophomore Year (fall):	Modern Visual Culture: 1789-1945
Sophomore Year (spring):	Contemporary Visual Culture: 1945 to the Present

After the sophomore year, students must take two elective academic art courses.

V. University Academic Courses

Eleven academic courses outside of Art are required.

Freshman Year

The student is required to take the following three courses:

Computing @ Carnegie Mellon, World History, and Interpretation and Argument.

After Freshman Year

The student must take one course in each of the following academic areas or "options":

- Humanities and Languages or "Culture Option"
- Math, Science and Engineering or "Technical Option"
- History, Psychology, Economics or "Social Science Option"

The student must then take at least three additional courses from ONE of the academic areas/options listed above.

Finally, the student must take two additional, but unspecified, academic electives.

In selecting courses for the university academic component of the curriculum, students are encouraged to complete a cluster of courses that appeals to and develops their interests as emerging artists. In the process of taking their university electives, students can often simultaneously earn a minor.

Bachelor of Fine Arts (B.F.A.) Curriculum

Below is the recommended distribution of courses in the four-year B.F.A. curriculum. After the freshman year, students may begin to choose university electives. After the sophomore year, students have more options regarding the sequencing and selection of their coursework.

First Year

	Fall	Units
60-101	Concept Studio I	10
60-110	Electronic Media Studio I: Computer Art	10
60-150	2D Media Studio I: Drawing	10
60-104	Contemporary Issues Forum	6
99-10x	Computing @ Carnegie Mellon	3
76-101	Interpretation and Argument	9
		48
	Spring	Units
60-102	Concept Studio II	10
60-130	3D Media Studio I: Ceramics, Welding, Wood	10
60-151	2D Media Studio II: Drawing	10
60-100	Critical Histories of the Arts	9
79-104	World History	9
		48

Second Year

	Fall	Units
60-201	Concept Studio III	10
60-230	3D Media Studio II: Foundry, Metals, Construction	10
60-250	2D Media Studio III: Painting	10
60-205	Modern Visual Culture: 1789-1945	9
xx-xxx	Academic Elective	9
		48
	Spring	Units
60-4xx	Advanced Studio Elective	10
60-210	Electronic Media Studio II: Video	10
60-251	2D Media Studio IV: Print Media	10
60-206	Contemporary Visual Culture: 1945 to the Present	9
xx-xxx	Academic Elective	9
		48

Third Year

	Fall	Units
60-301	Contextual Practice	10
60-4xx	Advanced Studio Elective	10
60-4xx	Advanced Studio Elective	10
60-xxx	Academic Art Elective	9
xx-xxx	Academic Elective	9
		48
	Spring	Units
60-302	Advanced Studio Elective	10
60-4xx	Advanced Studio Elective	10
60-4xx	Advanced Studio Elective	10
60-xxx	Academic Art Elective	9
xx-xxx	Academic Elective	9
		48

Fourth Year

	Fall	Units
60-401	Senior Project	10
60-4xx	Advanced Studio Elective	10
60-4xx	Advanced Studio Elective	10
60-3xx	Academic Elective	9
xx-xxx	Academic Elective	9
		48
	Spring	Units
60-402	Senior Project	10
60-4xx	Advanced Studio Elective	10
60-4xx	Advanced Studio Elective	10
xx-xxx	Academic Elective	9
xx-xxx	Academic Elective	9
		48

Total Units for the B.F.A. Art Degree

384

Sophomore and Senior Year Reviews

Students give an overview of their work twice in their four-year course of study. At the end of the sophomore year, students undergo a faculty review of their work to date in the program. A successful review is required for advancement to the junior year.

The senior review affords graduating students the opportunity to review, analyze and summarize their work and to engage a faculty committee in discussion about issues that face an artist preparing to enter a career in art.

Art Majors Minor or Double Majoring in Another Department

About a third of current B.F.A. Art students pursue a minor or a second major. If students are contemplating this option, they must discuss their plans with academic advisors from the minor or second major department as well as with the School of Art academic advisor.

Study Abroad

Art students are encouraged to spend either a semester of their junior year, or a summer before or after their junior year, in one of many available international programs. These programs include exchange programs sponsored by the School of Art in which a student's financial aid package remains in effect, and programs sponsored by other institutions. International exchange programs currently active include the following:

Brazil	Escola de Comunicacoes e Artes, Universidade de Sao Paulo, Sao Paulo
Chile	Instituto Superior de Arte y Comunicacion, Santiago
China	Chinese University of Hong Kong, Shatin, Hong Kong
Denmark	The Royal Danish Academy of Fine Arts, Copenhagen
Ecuador	Universidad de San Francisco de Quito, Quito
Finland	Kuvataideakademia, Helsinki
France	Ecole d'Aix-en Provence, Aix-en Provence Ecole nationale superieure des Beaux-Arts, Paris
Germany	Akademie der Bildenden Künste, Munich Universitat der Kunst Berlin, Berlin University of Applied Sciences, Hamburg University of Applied Sciences, (Kunstseminar) Schwabisch Hall University of Applied Sciences, Wedel
Ireland	Burren College of Art and Design, Burren
Israel	Bezalel Academy, Jerusalem
Japan	College of Art and Design, Nagoya Tokyo Institute of Polytechnics, Tokyo
Korea	The Korean National University of the Arts, Seoul
Netherlands	Gerrit Rietveld Academie, Amsterdam
New Zealand	Auckland Institute of Technology, Auckland
Scotland	Duncan Jordanstone College of Art and Design, Dundee
Spain	Glasgow School of Fine Art, Glasgow Universitat Politecnica de Valencia, Valencia
Turkey	Bilkent University, Ankara
Wales	University of Wales College, Newport

Programs with other Pittsburgh Institutions

Art students are eligible to take courses at the nearby University of Pittsburgh's History of Art and Architecture Department, at Pittsburgh Filmmakers, and at the Pittsburgh Glass Center. Established agreements with these institutions and other Pittsburgh colleges, universities or centers offer cross-registration opportunities at no additional expense to the student.

Bachelor of Humanities and Arts (B.H.A.) Degree

Bachelor of Science and Arts (B.S.A.) Degree

Bachelor of Computer Science and Arts (B.C.S.A.) Degree

Carnegie Mellon University offers a degree program that combines an Art Focus (11 courses for BHA and BSA, 12 courses for BCSA) with a focus in the College of Humanities and Social Sciences or the Mellon College of Science. The Assistant Head of the School advises BHA, BSA, and BCSA majors in selecting courses in the Art Focus. A description of these programs, and a list of requirements and electives, can be found in the in the BHA, BSA, and BCSA sections of this catalog.

Art Minors

Only students from other colleges and departments are eligible to pursue a minor in art. A minor requires six courses in the School of Art, selected from a list of requirements and electives as described in the CFA minors section of this catalog.

Master of Fine Arts (M.F.A.) Degree

The School of Art offers a three-year program leading to a Master of Fine Arts in Art. This is a unique program designed to connect artmaking to the university at large, and to Pittsburgh communities. Information about this program is available at the School of Art website: <http://art.cfa.cmu.edu>.

Master of Arts Management (M.A.M.) Degree

The College of Fine Arts and the H. John Heinz III School of Public Policy and Management co-sponsor a Master of Arts Management degree. Students admitted to the M.A.M. degree program in their junior year may complete both a Bachelor of Fine Arts degree and a Master of Arts Management degree in five years. Students interested in this graduate degree should consult with advisors early in their undergraduate program.

Pre-College Programs

The School of Art maintains two pre-college programs: a Saturday program during the academic year and a six-week program during the summer. These programs are designed to prepare the college-bound high school student for college level work in art. Information on these programs may be obtained by contacting the School of Art.

School of Art Faculty

Full-Time Tenure Track Faculty

KIM BECK, Associate Professor of Art — M.F.A., Rhode Island School of Design; Carnegie Mellon, 2004—.

JON BECKLEY, Professor of Art — M.F.A., Ohio University; Carnegie Mellon, 1979—.

PATRICIA BELLAN-GILLEN, Professor of Art — M.F.A. Carnegie Mellon University; Carnegie Mellon, 1986—.

RON BENNETT, Professor of Art — M.F.A. Rhode Island School of Design; Carnegie Mellon, 1975—.

BOB BINGHAM, Professor of Art — M.F.A. University of California, Davis; Carnegie Mellon, 1993—.

LOWRY BURGESS, Professor of Art — Post-Graduate Degree, Pennsylvania Academy of Fine Arts/University of Pennsylvania; Carnegie Mellon, 1989—.

JOHN CARSON, Professor of Art — M.F.A. California Institute of the Arts; Carnegie Mellon, 2006—.

TING CHANG, Assistant Professor of Art History — Ph.D. University of Sussex; Carnegie Mellon, 2006—.

JAMES DUESING, Professor of Art — M.F.A. University of Cincinnati; Carnegie Mellon, 1997—.

PAMELA JENNINGS, Assistant Professor of Art and HCII — M.F.A. School of Visual Arts; Carnegie Mellon, 2001—.

ANDREW JOHNSON, Associate Professor of Art — M.F.A. Carnegie Mellon University; Carnegie Mellon, 2004 —.

ELAINE A. KING, Professor of Art History and Theory — Ph.D. Northwestern University; Carnegie Mellon, 1981—.

CAROL KUMATA, Professor of Art — M.F.A. University of Wisconsin, Madison; Carnegie Mellon, 1979—.

GOLAN LEVIN, Associate Professor of Art — M.S. Massachusetts Institute of Technology; Carnegie Mellon, 2004—.

JOSEPH MANNINO, Professor of Art — M.F.A. University of Southern Illinois; Carnegie Mellon, 1986—.

CLAYTON MERRELL, Associate Professor of Art — M.F.A. Yale University; Carnegie Mellon, 1998—.

AYANAH MOOR, Assistant Professor of Art — M.F.A. Tyler School of Art; Carnegie Mellon, 1999—.

RICHARD PELL, Assistant Professor of Art — M.F.A. Rensselaer Polytechnic Institute; Carnegie Mellon, 2008—.

MARTIN PREKOP, Professor of Art — M.F.A. Rhode Island School of Design; Carnegie Mellon, 1993—.

MELISSA RAGONA, Assistant Professor of Art — Ph.D. State University of New York at Buffalo; Carnegie Mellon, 2003—.

HILARY ROBINSON, Dean of the College of Fine Arts, Professor of Art — Ph.D. University of Leeds; Carnegie Mellon, 2005—.

JON RUBIN, Assistant Professor of Art — M.F.A. California College of Arts and Crafts; Carnegie Mellon, 2006—.

SUZIE SILVER, Associate Professor of Art — M.F.A. The School of the Art Institute of Chicago; Carnegie Mellon, 1999—.

SUSANNE SLAVICK, Professor of Art — M.F.A. Tyler School of Art; Carnegie Mellon, 1984—.

MARY WEIDNER, Professor of Art — M.F.A. Washington University; Carnegie Mellon, 1976—.

Full-time Joint Appointments

CHARLEE BRODSKY, Associate Professor of Art and Photography — M.F.A. Yale University; Carnegie Mellon, 1978— .

ROGER DANNENBERG, Senior Research Computer Scientist and Artist — Ph.D. Carnegie Mellon University; Carnegie Mellon, 1982— .

JUDITH SCHACHTER, Professor of Anthropology, History, and Art — Ph.D. University of Minnesota; Carnegie Mellon, 1984— .

Visiting Faculty

JACOB CIOCCI, Visiting Assistant Professor of Art — M.F.A. Carnegie Mellon University; Carnegie Mellon, 2008—.

OSMAN KHAN, Visiting Assistant Professor of Art — M.F.A. University of California, Los Angeles; Carnegie Mellon, 2006—.

JILL MILLER, Visiting Assistant Professor of Art and HCII — M.F.A. University of California, Los Angeles; Carnegie Mellon, 200—.

Adjunct Courtesy Appointments

ROBERT BECKMAN, Adjunct Assistant Professor of Art — M.F.A. Kent State University; Carnegie Mellon, 2001—.

DOUGLAS FOGLE, Curator of Contemporary Art, Carnegie Museum of Art; Ph.D. University of California, Santa Cruz.

PATRICIA MAURIDES, Adjunct Professor of Art — M.F.A. Carnegie Mellon University; Carnegie Mellon, 1999—.

HEATHER PESANTI, Assistant Curator of Contemporary Art, Carnegie Museum of Art; M.A. Institute of Fine Arts, NYU.

DYLAN VITONE, Assistant Professor of Design and Art,; M.F.A., Massachusetts College of Art.

School of Design

Stephen Stadelmeier, Interim Head
Office: Margaret Morrison Carnegie Hall 110
<http://design.cmu.edu>

Design at Carnegie Mellon

Design is the thoughtful activity that humanizes our environment through visual communication and the shaping of products that help us in our daily lives. Whether in magazines and books, posters and exhibitions, video and film, human-computer interactions, or any of the myriad of everyday products such as furniture, consumer goods, vehicles, or medical equipment, designers play an important role in shaping the form and content of our experience.

Designers are concerned with aesthetics, but they are equally concerned with serving people. This requires more than skill in the fine arts. It also requires knowledge about the needs, desires, expectations, and capabilities of human beings. It requires skills of observation and interpretation that help us understand the people that we want to serve. More than this, however, designers must also understand the technological issues that stand behind effective products. They must understand the materials, tools, and production processes of the modern world. An education in design is an education for the mind as well as the eye and hand.

The emphasis in the School of Design is on professional preparation for an increasingly complex world in which design is an integrative discipline that supports the quality of human interaction in daily life. Designers must be able to integrate aspects of aesthetics and form giving, the social and behavioral sciences, natural sciences, and engineering. In addition, designers must be able to work effectively in teams of experts with specialized knowledge drawn from many disciplines. Therefore, the vision of design operating behind the School of Design contrasts sharply with visions that seek to reduce design to a fine art, a branch of engineering, or an area of the social sciences. The central theme of the School is communication and human experience. This reflects a new humanistic vision of design in the contemporary world, where a premium is placed on the designer's ability to invent, judge, make decisions, and evaluate for the purpose of improving the quality of life. For the design school at Carnegie Mellon, design is a new liberal art of technological culture.

The School offers two majors in design, with corresponding design minors programs.

B.F.A. in Communication Design

The goal of the Communication Design program is to prepare students with an understanding and mastery of the principles, theories, and skills of communication design. We define communication design as the effective presentation of ideas and information by means of type and image, whether in the traditional medium of print or the new digital medium that supports interactive computer display, multi-media communication technology, and information systems. What is common to the range of experiences in the program is a problem-solving approach to effective and expressive communication, with a special concern for the human being who will be touched by the communication artifact. We emphasize a design practice that is informed with an understanding of the social and cultural dimensions of communication, along with an appreciation of the power of words, images, sound, and movement. This is a forward looking program. While we foster a respect for the rich history of book, letterform, and print design, we are also fascinated with the potential that technology and new theories of human-machine interaction hold for the design of future modes of communication.

B.F.A. in Industrial Design

The goal of the Industrial Design program is to equip designers for a world that places a high value on the quality of human interactions. We all need products, devices, and designs that support and enhance these exchanges. To this end, we emphasize a design process strongly flavored by user testing, observation, and modeling, while preserving the richness of the visual and formal traditions in the field. The program approaches a balance by speaking clearly to several issues in the design process: how we understand the diverse qualities and needs of human beings, how we respond to those qualities and needs, how we make creative applications of appropriate technologies, how we gain a

perspective on the place of design in the economic and social life that is characteristic of contemporary culture, and how we expand our awareness of the place of design in history and in shaping the future.

Design Minors Program

The School also offers a minor in Communication Design and a minor in Industrial Design for well-qualified students. Further information on minors programs is provided earlier in the catalog.

The Design Curriculum

The design curriculum is for students who are interested in a full-time undergraduate study leading to entry-level professional employment or advanced graduate study in the areas of Communication Design or Industrial Design. The first year is a period of discovery, where students in both majors explore studio projects and supporting courses in the ideas and methods of design practice as well as courses in design studies. The second and third years are a period of concentration and development primarily within the student's major. The fourth year is a period of integration and advanced study, with studio projects involving teams of students from both majors as well as students from related fields. There are studio courses throughout all four years, supported by departmental electives in the ideas and methods of design practice and other courses in the history, theory, and criticism of design. In addition, the School also requires all students to take a substantial number of general education courses offered by other departments throughout the university. General education is an essential part of the education of a professional designer.

The First-Year Experience: Discovery

The first-year program in design provides a broad base for later specialization. Students are introduced to the three main tracks of the department: studio experience, ideas and methods of design practice, and design studies in history, theory, and criticism. Students are exposed to fundamental design processes, techniques, and ideational methods. They learn new ways of seeing and understand-ing familiar objects, of drawing and visualizing ideas and concepts, and how to use all of the resources of design to give form to ideas. Faculty members review each student's progress at the end of every semester. Faculty members also counsel students regarding both personal interests and educational objectives, so that a wise choice may be made between majoring in communication design or industrial design. In addition, students also take courses outside of the School for a sound general education.

This is the first-year curriculum for all design students.

First Year

	Fall	Units
Studio		
51-101	Design Studio I	9
Ideas and Methods		
51-121	Design Drawing I	9
Design Studies		
51-171	Human Experience in Design	9
General Education		
76-101	Interpretation & Argument	9
85-100	Introduction to Intelligence	9
99-101	Computing @ Carnegie Mellon	3
	Spring	Units
Studio		
51-102	Design Studio II	9
Ideas and Methods		
51-122	Design Drawing II	9
51-132	Introduction to Photographic Design	9
Design Studies		
65-100	Critical History of the Arts	9
General Education		
79-104	Introduction to World History	9

The Second- and Third-Year Experience: Concentration and Development

Following the first-year program, students enter one of the professional design majors: communication design or industrial design. Each option is built around six semesters of required and elective courses, covering the sophomore, junior, and senior years. The courses pose increasingly complex design problems similar to those faced by professional designers. They require students to use all of their creative, technical, and theoretical skills. In addition to studios, each option also requires a series of ideas and methods courses and a series of design studies courses covering design history, theory, and criticism as well as issues of professional practice. Students are also required to take general education courses to gain a broad vision of many disciplines and fields of knowledge that are relevant to design.

Communication Design

This is the second and third-year curriculum for students in communication design, with required courses noted in bold type and other available courses (often open to students of industrial design as well as communication design) noted in regular type. While required courses must be taken in proper sequence, other available courses may be taken later, when the student's schedule permits. Please see the course descriptions section for a complete listing of design courses.

Second Year

	Fall	Units
Studio		
51-201	Basic Typography: CD Studio I	9
Ideas and Methods		
51-203	Communication Design Computer Lab	3
51-241	How People Work: Human Factors	9
51-229	Digital Photographic Imaging	9
Design Studies		
51-271	Design History I	9
General Education		
xx-xxx	Academic Elective	9
	Spring	Units
Studio		
51-202	Intermediate Typography: CD Studio II	9
Ideas and Methods		
51-222	Color and Communication	9
51-224	Digital Prepress Production	9
Design Studies		
51-272	Design History II	9
General Education		
xx-xxx	Academic Elective	9

Third Year

	Fall	Units
Studio		
51-301	Advanced Typography: CD Studio III	9
Ideas and Methods		
51-321	Photography and Communication	9
51-323	Drawing and Communication	9
51-327	Web Design	9
51-333	Poster Design	9
Design Studies		
51-371/398	Topics in Design Studies	9
Other		
51-399	Junior Independent Study	var.
General Education		
xx-xxx	Academic Elective	9
xx-xxx	Free Elective	9

	Spring	Units
Studio		
51-302	Typography IV	9
Ideas and Methods		
51-324	Basic Prototyping Methods (for Communication Design)	4.5
51-330	Photo Book Design	9
51-350	Visualization	9
Design Studies		
51-372/398	Topics in Design Studies	9
Other		
51-399	Junior Independent Study	var.
General Education		
xx-xxx	Academic Elective	9
xx-xxx	Free Elective	18

Industrial Design

This is the second and third-year curriculum for students in industrial design, with required courses noted in bold type and other available courses (usually open to students of communication design as well as industrial design) noted in regular type. While required courses must be taken in proper sequence, other available courses may be taken later, when the student's schedule permits. Please see the course descriptions section for a complete listing of design courses.

Second Year

	Fall	Units
Studio		
51-211	Generation of Forms: ID Studio I	9
Ideas and Methods		
51-241	How People Work: Human Factors	9
51-243	Basic Prototype Methods (mini 1)	4.5
51-251	Digital Prototyping (mini 2)	4.5
Design Studies		
51-272	Design History II	9
General Education		
xx-xxx	Academic Elective	9
	Spring	Units
Studio		
51-212	The Meaning of Forms: ID Studio II	9
Ideas and Methods		
51-242	How Things Work: Mechanics and Electronics	9
51-246	Photo-Documentation for Industrial Design	4.5
Design Studies		
51-274	Design and Social Change	9
General Education		
xx-xxx	Academic Elective	9
xx-xxx	Free Elective	3-9

Third Year

	Fall	Units
Studio		
51-311	Product Design: ID Studio III	9
Ideas and Methods		
51-341	How Things are Made: Production Methods	9
51-327	Web Design	9
Design Studies		
51-371-398	Topics in Design Studies	9
Other		
51-399	Junior Independent Study	var.
General Education		
xx-xxx	Academic Elective	9
xx-xxx	Free Elective	9

Spring		Units
Studio		
51-312	Products in Systems: ID Studio IV	9
Ideas and Methods		
51-344	Adv. Digital Prototyping	6
51-346	Production Prototyping	6
51-350	Visualization	9
Design Studies		
51-371-398	Topics in Design Studies	9
Other		
51-399	Junior Independent Study	var.
General Education		
xx-xxx	Academic Elective	9
xx-xxx	Free Elective	9

The Fourth-Year Experience: Integration and Advanced Study

In the senior year, the studio experience is primarily about team projects. These projects typically involve cooperation with an external sponsor or client, with a combination of communication designers and industrial designers working in teams. The client agrees to participate as an information source, consultant, and project critic. All members of the team typically work on different aspects of a complex problem which is defined in conjunction with the client. Individual initiative and self-pacing are essential, but frequent group discussions and client reviews keep each student accountable to the team.

This is the fourth-year curriculum for all students, with required courses noted in bold type and other available courses (usually open to students of both communication design and industrial design) noted in regular type. Each senior signs up for one senior project in each semester.

Fourth Year

Fall (Choose one project.)		Units
Studio		
51-403	Sr. Project: Interaction Design	12
51-405	Sr. Project: Communication Design	12
51-407	Sr. Project: Product Design	12
51-409	Sr. Project: Environmental Design	12
Ideas and Methods		
51-421	Visual Interface Design	9
51-423	Design Computing	9
51-433	Advanced Interaction & Visual Interface	9
51-451	Fundamentals of Joinery and Furniture Design (I)	9
51-441	Product Planning & Development	4.5
51-426	Letterpress & Bookbinding	9
Design Studies		
51-471	Issues of Professional Practice	9
51-441	Product Planning & Development	4.5
Other		
51-499	Senior Independent Study	var.
General Education		
xx-xxx	Academic Elective	9
xx-xxx	Free Elective	9
Spring (Choose one project.)		Units
Studio		
51-404	Sr. Project: Interaction Design	12
51-406	Sr. Project: Communication Design	12
51-408	Sr. Project: Environmental Design	12
51-414	Sr. Project: Integrated Product Development	12
Ideas and Methods		
51-426	Letterpress and Bookbinding	9
51-452	Furniture Design (II)	9
51-424	Interactive Programming for Design	9
51-428	Time, Motion & Communication	9
Design Studies		
51-472/398	Topics in Design Studies	9
Other		
51-499	Senior Independent Study	var.
General Education		
xx-xxx	Academic Elective	9
xx-xxx	Free Elective	18

Other Requirements

General education courses should be selected from other departments throughout the university. Students are strongly advised to select a balanced set of general education electives—in addition to Interpretation and Argument, World History and Introduction to Intelligence— from three broad areas of study: arts and humanities, social and behavioral sciences, and natural sciences and engineering, including mathematics. Specific recommendations (and general requirements) for electives in all of these areas are available from advisors in the School of Design. The School places strong emphasis on the value of general education for personal growth as well as professional development. General education electives allow a student to obtain a minor in another department or program, such as business, engineering, professional and technical writing, or architecture.

Students may enroll for no more than 18 units of independent study courses, and no more than one independent study per semester. A minimum 3.0 GPA is required for independent study. Independent study is permitted only in the third and fourth years of the program. Proposals for independent study courses must be developed jointly by the student and a faculty advisor. Guidelines are available from the School.

A minimum GPA of 2.0 is required to maintain Professional Program status. Grades lower than "C" in required Design courses will result in academic probation, suspension, or drop from the School of Design.

Full-time students are required to enroll for a minimum of 45 units per semester (typically five courses). The minimum number of units required for graduation in Design is 360.

Standards

The design curriculum adheres closely to the fundamental professional entry-level standards established by the two leading national design organizations: the American Institute of Graphic Arts (AIGA) and the Industrial Designers Society of America (IDSA). The curriculum is accredited by the National Association of Schools of Art and Design (NASAD).

Applications

The School of Design accepts applications from students who are completing secondary education or who wish to transfer from within Carnegie Mellon University. The School also accepts applications from students who wish to transfer from other institutions. Students applying for the program are asked to either 1) submit a portfolio or 2) complete a design project (available as a PDF on the Design web site) as evidence of design ability. This is considered in balance with evidence of academic ability, based on secondary school grades, SAT scores, class rank, and letters of recommendation. The School also accepts applications for the design minors program for a limited number of spaces. Details are available from the design office.

Faculty

ERIC ANDERSON, Associate Professor of Design — M.A., Ohio State University; Carnegie Mellon, 1998—.

MARK BASKINGER, Assistant Professor of Design — M.F.A., University of Illinois; Carnegie Mellon, 2003 —.

DANIEL BOYARSKI, Professor of Design — M.F.A., Indiana University; School for Design, Kunstgewerbeschule, Basel, Switzerland; Carnegie Mellon, 1982—.

CHARLEE MAE BRODSKY, Professor of Photography — M.F.A., Yale University; Carnegie Mellon, 1978—.

WAYNE CHUNG, Associate Professor of Design — MID, University of the Arts; Carnegie Mellon, 2007—.

SHELLEY EVENSON, Associate Professor of Interaction Design — B.S. Ohio State University; Carnegie Mellon, 2003 —.

JODI FORLIZZI, Associate Professor, joint faculty in Design and Human Computer Interaction Institute — MDes, Carnegie Mellon University; Carnegie Mellon, 2000 — .

BRUCE HANINGTON, Associate Professor of Design — Master of Environmental and Industrial Design, University of Calgary; Carnegie Mellon, 1998—.

KRISTIN HUGHES, Associate Professor of Design — M.F.A., Virginia Commonwealth University; Carnegie Mellon, 2001— .

MARK MENTZER, Professor of Drawing — B.F.A., Carnegie Mellon University; Carnegie Mellon, 1975—.

THOMAS L. MERRIMAN, Teaching Professor in Design — B.F.A., Carnegie Mellon University; Carnegie Mellon, 1985—.

STACY ROHRBACH, Assistant Professor of Design — MGD, North Carolina State University; Carnegie Mellon, 2003 — .

STEPHEN J. STADELMEIER, Associate Professor of Design — M.S., Cornell University; Carnegie Mellon, 1977—.

ROBERT O. SWINEHART, Professor of Design — M.F.A., Northern Illinois University; Carnegie Mellon, 1974—.

DYLAN VITONE, Assistant Visiting Professor — M.F.A., Massachusetts College of Art; Carnegie Mellon, 2004—.

JOHN ZIMMERMAN, Associate Professor, joint faculty in Design and Human Computer Interaction Institute — MDes, Carnegie Mellon University; Carnegie Mellon, 2002 — .

Adjunct Faculty

MATT BEALE, Adjunct Assistant Professor — B.F.A., University of Michigan

VICTORIA CROWLEY, Adjunct Instructor — B.F.A., Carnegie Mellon University

KAREN MOYER, Adjunct Associate Teaching Professor — B.F.A., Philadelphia College of Art; Carnegie Mellon, 1978—.

EDWARD PETROSKY, Adjunct Instructor

MYRNA ROSEN, Adjunct Instructor

MATTHEW SASS, Adjunct Instructor — B.F.A., Carnegie Mellon University

LISA VITALBO, Adjunct Instructor — B.F.A., Carnegie Mellon University

Courtesy Appointments

RANDY PAUSCH, Associate Professor and Co-Director of the Entertainment Technology Center — Ph.D., Carnegie Mellon University.

JONATHAN CAGAN, George Tallman Ladd Professor of Mechanical Engineering — Ph.D., University of California Berkeley.

Special Faculty

JOSEPH M. BALLAY, IDSA, Professor of Design, Emeritus — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1970—2002.

EDWARD FISHER JR., Associate Professor of Design, Emeritus; Carnegie Mellon, 1965–1988.

HOWARD WORNER, Associate Professor of Design, Emeritus.

School of Drama

Dick Block, Interim Head

Office: Purnell Center for the Arts, 221

The information contained in this section is accurate as of July 31, 2008, and is subject to change. Please contact the School of Drama with any questions.

The School of Drama at Carnegie Mellon University is the oldest drama program in the country. CMU Drama offers rigorous, world-class classical training in theatre while providing thorough preparation for contemporary media.

As a member of the Consortium of Conservatory Theatre Training Programs, the school chooses students to participate in the program based on their potential ability. Every Drama student is treated as a member of a theatrical organization and must acquire experience in all phases of the dramatic arts. Students are also asked to broaden their knowledge through courses in the other colleges of the university. The undergraduate Drama program, which incorporates approximately 200 students, leads to a Bachelor of Fine Arts in Drama. The options available are: Acting, Music Theatre, Design, Production Technology and Management, Directing, Dramaturgy, and Theatre Studies. The production of plays, a natural extension of demanding class work, is our lab, and constitutes one of the school's major activities. The choice of texts used is determined by the particular needs of current students. Each semester, 15 to 25 lab productions, directed by faculty, guest directors, and advanced students, are presented in our three theatre spaces. The labs range from completely mounted, full-length dramatic and musical works to more simply produced directing projects and one-acts. The Drama program is rigorous and exacting, making demands on students that necessitate good health, a willingness to work and a commitment to professional discipline at all times. Because of full daytime class work and heavy production schedules, much production preparation takes place in the evening. Drama students, therefore, are advised to live in residence halls or in the immediate vicinity of the campus.

Acting Option

The Acting option is designed to prepare the student for immediate entry into the profession. It is a sequence-based training program with accumulative skills building upon each other over the course of four years. It is a conservatory training course, and the curriculum focuses primarily on the technique and craft of theatre. At the same time it offers skills that are applicable to all media. Courses in acting, voice, speech, movement, and theatre history are integral parts of the program at all four levels.

In addition to studio classes, Acting majors are required to take at least one liberal arts class each semester outside the school of drama to expand their intellectual curiosity and worldview.

All students must demonstrate a commitment to growth, show continued progress in their work and in the knowledge of their craft, and show a respect for professional standards in discipline, quality and ethics.

The freshman year is a discovery year and provides an introduction to basic skills—working from self, learning to play objectives and actions and the beginning of character exploration.

In the sophomore year these skills are solidified and deepened as more sophisticated, verbally complex material is introduced, through a focus on in-depth scene study, both contemporary and Shakespeare.

In the junior year students continue to develop their craft by investigating a variety of styles, including Greek, Brecht, and Restoration. Skills are now tested and strengthened through public performance.

The senior year provides a bridge from training to the professional world and offers the opportunity to appear on the School of Drama's main stage.

At the end of the senior year, students are introduced to the profession through Showcase performances in New York City and Los Angeles. The privilege to participate in Showcase is subject to the approval of the School of Drama faculty and as a rule is granted only to students who have obtained the necessary credits for graduation.

Music Theatre Option

The students in the Music Theatre program share the training philosophy and much of the same curriculum as others in the acting option. In addition, they take courses particular to the demands of Music Theatre. These include private voice along with training in a variety of dance techniques (Ballet, Jazz, Tap and Broadway Styles) and music theatre styles and skills.

Directing Option

The Undergraduate Directing program promotes creativity, intellectual curiosity, a broad and well-rounded understanding of the theatre and leadership ability. It provides a detailed exploration of the technique of directing for stage and for camera. The curriculum is designed for those serious about the art of directing and intending to pursue a career in theatre, film or television.

Course work in scene design, lighting and costume design develops the students' visual sophistication as well as an understanding of how these elements combine in practical production situations. Stage management skills are studied and practiced. Theatre history, criticism, playwriting, play development and theatre management classes introduce the student to the wide range of knowledge necessary for directing. There are many avenues open for practical application: scene work in class, a short film written and directed by the students, opportunities in multi-camera directing and a studio project. The broad scope of the directing curriculum encourages the director's interaction with all the theatrical disciplines. Collaboration in all forms, so necessary to the art, is the goal.

Design Option

Design students are expected to develop artistic ability in the conception and execution of scene, lighting, sound and costume design for plays of all periods under varying theatrical conditions. Students may elect to have a focus on one or two areas but must have a solid background in all four. Freshmen in design receive instruction in drawing and painting, three-dimensional techniques, and in the application of basic design principles through courses in drawing and design. Sophomores learn to apply design principles to the theatre through research, play analysis, and studies in the fundamentals of scene, lighting, sound and costume design. Design assignments cover various styles and periods and include the preparation of models, renderings, and working drawings, lighting storyboards, and light plots. Juniors and Seniors take specialized courses in two areas of stage design and are expected to head studio and mainstage production crews. As part of the degree work, juniors may design sets, lights, sound or costumes for a production in the Studio Theatre and seniors may design sets, lights, sound or costumes for a Master's thesis show or a mainstage production. Designing for lab productions, both those that are highly resourced and those that are moderately resourced, requires a variety of creative approaches, preparing designers for a variety of real-world situations.

Design Option Yearly Goal Statements

Freshman Year (Design and PTM)

The Freshman Year in Design/PTM introduces the student to the broader foundation skill sets upon which they will build their CMU education and subsequent careers. One of the primary educational objectives of this year is for the student to develop their creative problem solving skills. Freshman Year is also designed to foster a sense of community as a member of the School of Drama ensemble through work on productions and to instill a sense of personal responsibility.

Sophomore Year

The Sophomore Year builds upon the skills obtained during the Freshman Year by attaching those skills to particular theatrical or storytelling applications and concepts. Student's problem solving skills begin to be directed toward the theatrical design and production processes. Breadth and depth of knowledge in theater and the larger world become ongoing curricular objectives. Ensemble work continues, as students get more involved in the theater making process through production labs. Students will also choose an Option (Design or Production Technology and Management) and area of focus in the Sophomore Year.

Junior Year

During the Junior Year the student establishes some depth in a particular area or areas of design. Design classes are rigorous and focused and encourage students to explore idea building, process and in-depth skill work. Juniors will also significantly extend their knowledge base with history classes specific to design, more skills classes and production work specific to their areas of study. Production work includes an opportunity for the first realized design and a chance to participate in crew leadership. The Junior's curricular work is broadened by an out of School of Drama elective each semester.

Senior Year

The Senior Year is designed to sharpen and polish the processes and skills learned in the first three years. Seniors are also involved in preparations for launching a career; resumes and portfolios will be created and any holes in the student's design process will be addressed. The core design classes continue to be intensive and even more focused. Seniors are leaders in the production process and have an opportunity to design production labs supported by crews and a greater degree of material resources. The student's curricular work continues to be broadened by an out of School of Drama elective each semester.

Dramaturgy Option

Dramaturgy is the number-one growth field in the entertainment industry. Dramaturgs are theatre insiders who thrive on the process of being behind living theatre events. They love reading, writing, and thinking and believe in the power of theatre to enlighten, stimulate and entertain audiences. Through Carnegie Mellon University's new and innovative Dramaturgy Option you'll become an expert on historical practices and aesthetic theories behind any text, whether in production or waiting to come alive on stage. You will have the insights to reveal playwrights' intentions and the ability to communicate them to producers, directors, performers, and audiences.

The Dramaturg adapts traditional, historical, and classic texts for the modern stage; aids directors, designers, and performers in clarifying their insights; collaborates with artistic directors in choosing exceptional repertory; finds social relevance in every work; links audiences with the ideas behind the productions in program notes, lectures, and talk-backs.

You will receive rigorous, highly structured academic and artistic training; broad and deep historical research; intensive study of aesthetic and critical theories; practical, professional-level experience in full scale theatre productions; opportunities to develop diversity by studying with Carnegie Mellon University professors in other arts as well as in the sciences and humanities; opportunities to study abroad; opportunities to work with professional companies in the US, Asia, Latin America, Africa, and Europe.

Your career possibilities include literary management; story editing for films and television; production dramaturgy; teaching: developing the talents and insights of students at educational institutions.

Production Technology and Management Program (PTM)

The Production Technology and Management Program develops the technologists and managers of the future with an intensive curriculum designed to synthesize academic development and production experience. The curriculum focuses on the production requirements of live performance, in the form of traditional theatrical presentation, while also providing exposure to television, film and emerging technology-based art forms. Integrated in a world class research university environment, the School of Drama is uniquely positioned to contribute to the advancement of the collaborative arts. The goal of the PTM program is to prepare today's students to become tomorrow's leading professionals in the entertainment industry.

All undergraduate students begin with the development of visual and written communication skills. The first four semesters immerse the student in a range of collaborative and individual studies: scenery, costume, sound and lighting design fundamentals; dramatic structure and interpretation; manual and computer-based drafting; perspective and figure drawing, fundamentals of directing; production management and preparation, history of art and history of architecture and décor. The last four semesters focus in the student's analytical skills within their chosen area of concentration: technical direction or stage/production management.

Technical Directors are offered classes in: material applications, metal working techniques, structural design, scenic crafts, fabrication design and detailing, machinery design, rigging techniques, power system and electronic design fundamentals, introduction to sound design, automation system technology, technical management and production management. Technical Directors may take a single semester internship at an approved regional or commercial producing organization, in lieu of one semester of study. Student selected elective courses, outside the School of Drama, provide balance and breadth to the professional undergraduate education offered in the PTM program of study.

Stage Managers and Production Managers are offered classes in: stage management, production planning and scheduling, theater management, introduction to accounting, cash budgeting, producing for television and film, camera lab, computer applications, technical management, organizational behavior, principles of economics, business communications and production management workshop. Stage and Production Managers may take a single semester internship at an approved regional or commercial producing organization, in lieu of one semester of study. Student selected elective courses, outside the School of Drama, provide balance and breadth to the professional undergraduate education offered in the PTM program of study.

Theatre Studies Option

The Theatre Studies program offers students from any of the School's conservatory areas of specialized study the opportunity to continue developing their theatre related skills while expanding their interests to other artistic and academic areas. This option will only be available to Drama students that have completed the sophomore year of the training program.

The goal of the Theatre Studies program is to enable students to explore the diverse opportunities for which conservatory drama training can be a basis, and to examine the possibility of post graduate education in a new area of specialization after obtaining a BFA in Drama. As the intent of the Theatre Studies option is to broaden your experiences, a semester studying abroad or participating in a recommended internship is required for one semester, either in the Fall or Spring.

Individualized courses of study are established for each student in consultation with the Theatre Studies program director which reflect the students current interest. However the following requirements for core course work must also be fulfilled.

Acting Option

Freshman Year

Fall		Units
54-011	Warmup	1
54-101	Acting I	12
54-103	Speech I	6
54-105	Voice/Alexander I	5
54-107	Movement I	4
54-111	Text	2
54-159	Production Symposium I	6
54-175	Conservatory Hour	1
54-177	Foundations of Drama I	6
64-100	Critical Histories of the Arts	9
or		
76-101	Interpretation and Argument (English)	9
99-101	Computing at Carnegie Mellon	3

Minimum units - 55

Spring		Units
54-012	Warmup	1
54-102	Acting I	12
54-104	Speech I	6
54-106	Voice/Alexander I	5
54-108	Movement I	4
54-160	Production Symposium I	6
54-176	Conservatory Hour	1
54-178	Foundations of Drama II	6
64-100	Critical Histories of the Arts	9
or		
76-101	Interpretation and Argument (English)	9
xx-xxx	Non-Drama Elective	(minimum) 6

Minimum units - 56

Sophomore Year

Fall		Units
54-201	Acting II	12
54-203	Voice & Speech II	5
54-207	Movement II	6
54-211	Actor Dance II	3
54-213	Singing for Actors II (optional)	3
54-221	Directing II	9
54-259	Production Symposium II	9
54-281	Foundations of Drama III	6
xx-xxx	Non-Drama Elective	(minimum) 6

Minimum units - 59

Spring		Units
54-202	Acting II	12
54-204	Voice & Speech II	6
54-208	Movement II	6
54-214	Singing for Actors II (Optional)	3
54-242	Improvisation	4
54-260	Production Symposium II	9
54-282	Foundations of Drama IV	6
54-294	Make-Up	2
54-322	Directing III	6
xx-xxx	Non-Drama Elective	(minimum) 6

Minimum units - 60

Junior Year

Fall		Units
54-301	Acting III	12
54-303	Speech III (accents)	6
54-305	Voice/Alexander III	6
54-307	Movement III	6
54-311	Acting Symposium III	10
54-317	Singing for Actors III (optional)	2
54-325	Actor Dance III	3
54-502	Junior Auditioning (optional)	2
54-xxx	History of Drama (if necessary)	3
xx-xxx	Non-Drama Elective	(minimum) 6

Minimum units - 55

Spring		Units
54-302	Acting III	12
54-304	Speech III (dialects)	6
54-306	Voice/Alexander III	3
54-308	Movement III	4
54-312	Acting Symposium III	10
54-318	Singing for Actors III (optional)	2
54-325	Actor Dance III	3

54-502	Junior Auditioning (optional)	2
54-xxx	History of Drama (if necessary)	3
xx-xxx	Non-Drama Elective	(minimum) 6

Minimum units - 49

Senior Year

Fall		Units
54-401	Camera Lab	6
54-405	Graduate Directing	6
54-407	Movement IV	6
54-409	Theatre Lab	4
54-411	Acting Symposium IV	20
54-413	Showcase	4
54-437	Acting for the Camera	4
54-494	Business of Acting	4
54-xxx	History of Drama (if necessary)	3
xx-xxx	Non-Drama Elective	(minimum) 6

Minimum units - 60

Spring		Units
54-402	Camera Lab	6
54-406	Graduate Directing	6
54-410	Theatre Lab	4
54-412	Acting Symposium IV	20
54-414	Showcase	9
54-487	Acting IV	9
54-xxx	History of Drama (if necessary)	3
xx-xxx	Non-Drama Elective	(minimum) 6

Minimum units - 60

Important: In addition to the 3-semester sequence of History of Drama, all Actors will be required to take a total of 2 Drama History Minis of varying topics over their junior and senior year.

Music Theatre Option

Freshman Year

Fall		Units
54-011	Warmup	1
54-101	Acting I	12
54-103	Speech I	6
54-105	Voice I	5
54-107	Movement I	4
54-111	Text	2
54-123	Ballet I	5
54-125	Music Skills I	2
54-159	Production Symposium I	6
54-175	Conservatory Hour	1
54-177	Foundations of Drama I	6
54-500	Voice Lab	5
64-100	Critical Histories of the Arts	9
or		
76-101	Interpretation and Argument (English)	9
99-101	Computing at Carnegie Mellon	3

Minimum units - 67

Spring		Units
54-012	Warmup	1
54-102	Acting I	12
54-104	Speech I	6
54-106	Voice I	5
54-108	Movement I	4
54-124	Ballet I	5
54-126	Music Skills II	2
54-160	Production Symposium I	6
54-176	Conservatory Hour	1
54-178	Foundations of Drama II	6
54-500	Voice Lab	5
64-100	Critical Histories of the Arts	9
or		
76-101	Interpretation and Argument (English)	9

Minimum units - 68

Sophomore Year

Fall		Units
54-201	Acting II	12
54-203	Voice & Speech II	5
54-205	Ballet II	3
54-207	Movement II	6

54-217	Jazz II	2
54-219	MT Lit and Rep	4
54-223	Tap II	2
54-259	Production Symposium II	9
54-281	Foundations of Drama III	6
54-500	Voice Lab	5

Minimum units – 55

Spring		
54-202	Acting II	12
54-204	Voice & Speech II	6
54-206	Ballet II	3
54-208	Movement II	6
54-218	Jazz II	2
54-224	Tap II	2
54-226	Acting a Song	4
54-260	Production Symposium II	9
54-282	Foundations of Drama IV	6
54-294	Make-Up	2
54-500	Voice Lab	5

Minimum units - 57

Junior Year

Fall		Units
54-301	Acting III	10
54-303	Speech III (dialects)	3
54-305	Voice III	6
54-311	Acting Symposium III	16
54-313	Ballet III	3
54-315	Jazz III	2
54-319	Cabaret	6
54-323	Tap III	2
54-500	Voice Lab	5
54-xxx	History of Drama (if necessary)	3

Minimum units – 53

Spring		
54-302	Acting III	10
54-304	Speech III (accents)	3
54-306	Voice III	3
54-312	Acting Symposium III	16
54-314	Ballet III	3
54-316	Jazz III	2
54-320	Music Theatre Scenes	6
54-324	Tap III	2
54-xxx	History of Drama (if necessary)	3

Minimum units – 45

Senior Year

Fall		Units
54-401	Camera Lab	6
54-407	Movement IV (optional)	6
54-409	Theatre Lab	4
54-411	Acting Symposium IV	20
54-413	Showcase	4
54-415	Broadway Styles	4
54-423	Tap IV	2
54-437	Acting IV	4
54-494	Business of Acting	4
54-500	Voice Lab	5
54-xxx	History of Drama (if necessary)	3

Minimum units - 59

Spring		
54-402	Camera Lab	6
54-410	Theatre Lab	4
54-412	Acting Symposium IV	20
54-414	Showcase	9
54-416	Broadway Styles	4
54-424	Tap IV	2
54-438	Acting for the Camera	4
54-500	Voice Lab	5
54-xxx	History of Drama (if necessary)	3

Minimum units - 54

Important: In addition to the 3-semester sequence of History of Drama, all Music Theatre majors will be required to take a total of 2 Drama History Minis of varying topics over their junior and senior year.

**Design Option
Freshman Year****Fall**

Basic Design	6
Basic PTM	6
Stagecraft	15
Studiocraft	13
Foundations of Drama	6
Critical Histories of the Arts	6
Computing @ Carnegie Mellon	3
Conservatory Hour	1

Spring

Basic Design	6
Basic PTM	6
Stagecraft	11
Studiocraft	8
Foundation of Drama	6
Conservatory Hour	1
Non-Drama Elective	9
Interpretation and Argument	9

Sophomore Year**Fall**

Oswald/The Wolf's Colon	6
Design for the Stage	6
Technical Management	6
Stagecraft II	14
Studiocraft II	3
Directing II	6
Foundations of Drama	6
Non-Drama Elective	9

Spring

<i>All Design</i>	
Foundations IV	6
Non- Drama Elective	6 or 9
Non-Drama Elective	9

Sound Design

Introduction to Sound Design	21
Production Audio	6

Costume Design

Introduction to Costume Design	21
Costume Construction	6
Costume Design Forum	n/a
Make up for Designers	2
Figure Drawing I	6

Set Design

Introduction to Scene Design	21
Set Design Forum	n/a
Scene Design Skills 3D	6
Scene Painting 1	6

Lighting Design

Introduction to Lighting Design	21
Lighting Design Forum	n/a

Junior Year**Fall**

<i>All Design</i>	
Production Prep III	12
History of Clothing	6
History of Architecture and Décor	6
Scene Design IB (not required)	9
Non-Drama Elective	9

Sound Design

Sound Design I	6
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Costume Design

Costume Design 1	6
Costume Construction	9
Costume Design Forum	n/a
Figure Drawing 1	6

Set Design

Scene Design I	9
Set Design Forum	n/a
Scene Design Skills	6
Scene Painting I	6

<i>Lighting Design</i>	
Lighting Design I	9
Automated Lighting	6
Lighting Design Skills	6
Lighting Design Forum	n/a

Spring

<i>All Design</i>	
Production III	12
History of Clothing	6
History of Architecture and Décor	6
Lighting Design 1E (not required)	9
Non-Drama Elective	9

<i>Sound Design</i>	
Sound Design I	9

<i>Costume Design</i>	
Costume Design I	9
Costume Construction	6
Figure Drawing I	6

<i>Set Design</i>	
Scene Design I	9
Set Design Forum	n/a
Scene Design Skills 3D	6
Photoshop/Dreamweaver	6
Scene Painting	6

<i>Lighting Design</i>	
Lighting Design	9
Production Electrics	6
Lighting Previsualization Software	6
Lighting Design Forum	n/a

Senior Year

Fall

<i>All Design</i>	
Production Prep III	15
Non- Drama Elective	9

<i>Sound Design</i>	
Sound Design II	9

<i>Costume Design</i>	
Costume/ Set Design II Scenography	9
Costume Construction II	6
Costume Design Forum	n/a
Figure Drawing II	6
Drawing for the Theatrical Designer	6

<i>Set Design</i>	
Costume/ Set Design II Scenography	9
Set Design Forum	n/a
Drawing for the Theatrical Designer	6
Scene Painting II	6

<i>Lighting Design</i>	
Lighting Design II	9
Lighting Design Forum	n/a

Spring

<i>All Design</i>	
Production Prep III	15
Non-Drama Elective	9

<i>Sound Design</i>	
Sound Design II	9

<i>Costume Design</i>	
Costume Design II	9
Costume Construction II	6
Costume Design Forum	n/a
Figure Drawing Two	6
Painting for the Theatrical Designer	6

<i>Set Design</i>	
Set Design Two	9
Set Design Forum	n/a
Painting for the Theatrical Designer	6
Scene Painting II	6

<i>Lighting Design</i>	
Lighting Design II	9
Lighting Design Forum	n/a

Directing Option

Freshman Year

		Units
Fall		
54-121	Directing I: Sources	9
54-101	Acting I	12
54-107	Movement I	4
54-177	Foundations of Drama I	6
54-517	Directors' Colloquium	1
54-159	Production Symposium I	6
54-175	Conservatory Hour	1
76-101	Interpretation & Argument	9
64-100	Critical Histories of the Arts	9
99-101	Computing @ Carnegie Mellon	3
xx-xxx	Non-Drama Elective	6-9

Minimum Units - 64

		Units
Spring		
54-122	Directing I: Sources	9
54-102	Acting I	12
54-108	Movement I	4
54-178	Foundations of Drama II	6
54-160	Production Symposium I	6
54-518	Directors' Colloquium	1
54-176	Conservatory Hour	1
xx-xxx	Non-Drama Elective	6-9

Minimum Units - 45

Second Year

		Units
Fall		
54-221	Directing II: Fundamentals	9
54-201	Acting II	12
54-251	Introduction to Lighting Design	6
54-281	Foundations of Drama III	6
54-517	Directors' Colloquium	1
54-257	Directing Production II	12
54-xxx	Make-Up (Optional)	2
54-277	Intro to Stage Management	6
xx-xxx	Non-Drama Elective	6-9

Minimum Units - 57

		Units
Spring		
54-222	Directing II: Fundamentals	9
54-202	Acting II	12
54-252	Introduction to Lighting Design	3
54-282	Foundations of Drama IV	6
54-518	Directors' Colloquium	1
54-258	Directing Production II	12
xx-xxx	Non-Drama Elective	6-9

Minimum Units - 46

Third Year

		Units
Fall		
54-321	Directing III: Forms and Formats	9
54-231	Design for the Stage	6
54-239	* History of Architecture & Décor	4
OR		
54-245	* History of Clothing	4
54-517	Directors' Colloquium	1
54-357	Directing Production III	12
54-277	Stage Management I	6
xx-xxx	Non-Drama Elective	6-9
54-xxx	History of Drama (Mini)	3

Minimum Units - 47

		Units
Spring		
54-322	Directing III: Forms and Formats	9
54-232	Design for the Stage	6
54-240	* History of Architecture & Décor	4
OR		
54-246	* History of Clothing	4
54-518	Directors' Colloquium	1
54-358	Directing Production III	12
54-xxx	Playwriting for Directors	6
xx-xxx	Non-Drama Elective	6-9
54-xxx	History of Drama (Mini)	3

Minimum Units - 47

Fourth Year

Fall		Units
54-401	Camera Lab	6
54-409	Theatre Lab	9
54-433	Producing for TV & Film	9
54-457	* Directing Production IV	12
54-517	Directors' Colloquium	1
54-475	Theatre Management	6
xx-xxx	Non-Drama Elective	6-9
54-xxx	History of Drama (Mini) (If Needed)	3

Minimum Units - 52

Spring		Units
54-422	Directing IV: Departures from Realism	6
54-410	Theatre Lab	9
54-xxx	TV Project	3
54-458	* Directing Production IV	12
54-518	Directors' Colloquium	1
54-xxx	History of Drama (Mini) (If Needed)	3

Minimum Units - 34

* One semester of Directing Production IV required - Senior Thesis Play. Second semester is optional.

Other Electives - Students in the School of Drama are required to take 448 units for graduation, or an average of 56 units per semester. After scheduling their required courses above, Directing Option students should fill the rest of their schedule with non-Drama electives, History of Drama mini (half-semester) courses, or additional electives. The Directing Option requirements, plus the non-Drama electives and History of Drama mini courses, total between 374 and 395 units, depending on the unit count of the non-Drama electives the student chooses. The student is free to take any courses they would like to fulfill the remaining 53 to 74 units, to bring their total to 448. In this way, the Directing curriculum provides students the option to make their education as broad as they wish. They may even choose to earn a minor in another discipline, by selecting their seven non-Drama electives and the additional 53 to 74 units deliberately.

Production Technology and Management Option

Freshman

Fall		Units
54-151	Stagecraft	15
54-157	Basic PTM	6
54-169	Studiocraft	13
54-171	Basic Design	6
54-175	Conservatory Hour	1
54-177	Foundations of Drama	6
64-100	Critical Histories of the Arts	6
99-101	Computing @ Carnegie Mellon	3

Minimum Units- 56

Freshman

Spring		Units
54-152	Stagecraft	11
54-158	Basic PTM	6
54-170	Studiocraft	8
54-172	Basic Design	6
54-176	Conservatory Hour	1
54-178	Foundations of Drama II	6
76-101	Interpretation and Argument	9
xx-xxx	Non-Drama Elective	9

Minimum Units- 56

Sophomore

Fall		Units
54-221	Directing II	6
54-231	OSWALD	6
54-250	Stagecraft II	14
54-266	Technical Management	6
54-271	Design for the Stage	6
54-280	Studiocraft II	3
54-281	Foundations of Drama III	6
xx-xxx	Non-Drama Elective	9

Minimum Units- 56

Sophomore

Spring		Units
54-272	Fabrication and Install	6
54-282	Foundations of Drama IV	6
54-330	Intro to Stage Management	6
54-334	Production Management I	6
xx-xxx	Directed Elective	3-12
xx-xxx	Non-Drama Elective	6-12
Technical Direction		
54-264	Welding	3
PM/SM		
54-166	Intro to Sound Design	6

Minimum Units- 44

Junior

Fall		Units
54-165	Introduction to Sound in Theater	6
54-273	Technical Direction	9
54-333	Production Management I	6
54-361	Production Prep III	12
54-475	Theater Management	6
54-381	History of Drama Mini	6
xx-xxx	Non- Drama Elective	6
xx-xxx	Non-Drama Elective	6
Technical Direction		
54-239	History of Architecture and Décor	4
PM/SM		
54-277	Stage Management I	6
54-339	Stage Management Seminar	3

Minimum Units- 55

Junior

Spring		Units
54-165	Introduction to Sound in Theater	6
54-366	Physics of Stage Machinery	9
54-362	Production Prep III	12
54-382	History of Drama Mini	6
xx-xxx	Non-Drama Elective	6
Technical Direction		
54-368	Production Electrics	6
54-778	Technical Design	9
PM/SM		
54-278	Stage Management I	6
54-340	Stage Management Seminar	3
54-380	Music Reading for Drama Tech	3

Minimum Units- 51

Senior

Fall		Units
54-461	Production Prep IV	15
xx-xxx	Non-Drama Elective	6
Technical Direction		
54-353	Structural Design I	9
54-365	Machine Design I	9
54-477	Technical Design II	9
PM/SM		
54-239	History of Architecture and Décor	4
54-359	Stage Management II	6
54-439	Stage Management Seminar	3
54-453	Production Mgmt. Workshop	3
90-775	Management Seminar for Artists	9

Minimum Units- 46

Senior

Spring		Units
54-240	History of Architecture and Décor	4
54-462	Production Prep IV	15
xx-xxx	Non-Drama Elective	6
Technical Direction		
54-354	Structural Design II	9
54-366	Machine Design II	9
54-477	Technical Design II	9
PM/SM		
54-356	Stage Management II	6
54-440	Stage Management Seminar	3
54-456	Production Mgmt. Workshop	3

Minimum Units -36

Dramaturgy Option

Freshman Year

	Units
Fall	
54-177 Foundations of Drama I	6
64-100 Critical Histories of the Arts	9
76-101 Interpretation & Argument	9
99-101 Computing @ Carnegie Mellon	3
54-109 Dramaturgy I	15(9)
82-101 Elementary French I [or similar]	9
xx-xxx Elective (drama or non-drama)	min 9

54

Spring

	Units
54-210 Text Analysis	6
54-174 Dramaturgy II	9
54-178 Foundations of Drama II	6
54-520 Interdisciplinary Symposium	3
82-102 Elementary French II [or similar]	9
xx-xxx Elective (drama or non-drama)	min 9

51

Sophomore Year

	Units
Fall	
54-239 History of Architecture and Décor	4
54-245 History of Clothing	4
54-281 Foundations of Drama III	6
76-294a Interpretive Practices I	9
76-245 Shakespeare – Comedies and Romances	9
82-201 Intermediate French I [or similar]	9
54-247 Directing II	9

50

Spring

	Units
76-247 Shakespeare – Tragedies and Histories	9
51-327 Introduction to Web Design	9
54-282 Foundations of Drama IV	6
54-520 Interdisciplinary Symposium	3
xx-xxx Elective (drama or non-drama)	9
79-207 Development of European Culture [or similar]	9
54-248 Directing III	9

54

Junior Year

	Units
Fall	
76-330 Medieval Literary and Cultural Studies	9
54-381/A1 History of Drama Mini I	3
54-381/A2 History of Drama Mini II	3
54-387/8 Dramaturgy Production: III [Fall or Spring]	9
79-223 Protest and Dissent in American History	9
79-258 Introduction to African History [or similar]	9
xx-xxx Elective (drama or non-drama)	9

51

Spring

	Units
76-331 Renaissance Literary and Cultural Studies	9
76-334 19 th Century Literary and Cultural Studies	9
76-335 20 th Century Literary and Cultural Studies	9
54-520 Interdisciplinary Symposium	3
54-382/A3 History of Drama Mini III	3
54-382/A4 History of Drama Mini IV	3
79-308 The Politics and Culture of Memory [or similar]	9
54-xxx Dramaturgy Research Hours	6

51

Senior Year

	Units
Fall	
54-381/A1 History of Drama Mini I-B	3
54-381/A2 History of Drama Mini II-B	3
54-487/8 Dramaturgy Production IV [Fall or Spring]	9
76-431 Adv Sem in British Literary and Cultural Studies	9
76-432 Adv Sem in African-American Studies	9
xx-xxx Elective (drama or non-drama)	9
54-785 Graduate Colloquium	9

51

	Units
Spring	
54-382/A3 History of Drama Mini III-B	3
54-382/A4 History of Drama Mini IV-B	3
54-489/90 Internship	9
1-341 History of Theory	6
54-xxx Thesis Hours [Fall or Spring]	9
76-444 Enlightenment Sexualities[or other 76-400]	9
54-520 Interdisciplinary Symposium	3
54-786 Graduate Colloquium	9

51

Theatre Studies

(curriculum to be individually tailored)

Units: 40 to 55 units per semester

Core Courses: History, English and Computing at Carnegie Mellon by the close of the sophomore year.

Electives: at least two non-drama electives per semester.

History of Drama: 6 minis required

Production: Production III & IV

Thesis: 54-291/92, 9 units

Production Assignments could involve one of the following activities:

Production Research

Production Promotion

Stage Managing

Assistant Stage Managing

Assistant Directing

Producing a project in corporation with another department

Graduation Thesis

Each student will be required to give an individual creative presentation in their area of study. Any creative thesis must be thoroughly documented and formally presented. Their presentation might take many forms and could be developed through an independent study with a faculty member upon approval of the Option Head.

Faculty

BARBARA ANDERSON, Professor, Drama/Design — M.F.A., Yale University; Carnegie Mellon, 1968—.

WENDY ARONS, Associate Professor, Dramatic Literature – Ph.D., University of California, San Diego; Carnegie Mellon, 2007 –

NATALIE BAKER-SHIRER, Associate Professor, Voice & Speech — M.F.A. University of Pittsburgh; Carnegie Mellon, 1992—.

CLAUDIA BENACK, Associate Teaching Professor, Music Theatre — M.F.A. Carnegie Mellon; Carnegie Mellon, 1993—.

DICK BLOCK, Interim Head, School of Drama, Associate Teaching Professor of Design — M.F.A., Northwestern University; Carnegie Mellon. 1988—.

DAVID BOEVERS, Assistant Professor, Production Technology and Management, Option Coordinator, PTM — M.F.A. Yale University; Carnegie Mellon, 2000 —.

JAMES CATON, Associate Teaching Professor, Dance — Carnegie Mellon, 1988—.

MICHAEL CHEMERS, Assistant Professor, Dramaturgy — Ph.D., University of Washington; Carnegie Mellon, 2004—.

JUDITH CONTE, Associate Teaching Professor, Dance — B.F.A., University of Wisconsin/ Milwaukee; Carnegie Mellon, 1978—.

THOMAS DOUGLAS, Associate Teaching Professor, Music Theatre — M.M. Duquesne University; Carnegie Mellon 1991—.

BYRON EASLEY, Teaching Professor, Dance – Alvin Ailey School of Dance; Dance Theatre of Harlem; Carnegie Mellon, 2007 –

JANET MADELLE FEINDEL, Associate Professor, Voice/Alexander — M.F.A. in Drama, Carnegie Mellon; Carnegie Mellon, 1996—.

MATTHEW GRAY, Assistant Professor, Acting – University of British Columbia; London Academy of Music and Dramatic Arts; Carnegie Mellon, 2005 –

JED ALLEN HARRIS, Associate Teaching Professor, Directing — M.F.A., Carnegie Mellon; Carnegie Mellon, 1991—.

KEVIN HINES, Associate Teaching Professor, Production Technology & Management — M.F.A. Yale University; Carnegie Mellon, 1998—.

BRIAN JOHNSTON, Professor Emeritus, Dramatic Literature — M.A. Honors, Cambridge University, England; Carnegie Mellon, 1986—.

MLADEN KISELOV, Professor Emeritus, Directing — Honors Graduate, Moscow Theatre Institute; Carnegie Mellon, 1992—.

GARY KLINE, Associate Teaching Professor, Music Theatre — B.F.A., Carnegie Mellon; Carnegie Mellon, 1990—.

GREGORY LEHANE, Professor, Directing — M.F.A., Carnegie Mellon ; Carnegie Mellon, 1991—.

CINDY LIMAURO, Professor, Lighting Design — M.F.A., Florida State; Carnegie Mellon, 1987—.

BARBARA MacKENZIE WOOD, Professor, Acting; Option Coordinator, Acting/MT — M.F.A., Carnegie Mellon; Carnegie Mellon, 1986—.

DON MARINELLI, Professor, Drama and Arts Management, Co-Director of ETC — Ph.D., University of Pittsburgh; Carnegie Mellon, 1981—.

DANIEL J. MARTIN, Associate Professor, Drama, Director of the Master of Arts Management Program, Director of the Carnegie Mellon Center for Arts Management and Technology.

ANTHONY McKAY, Associate Professor, Acting — B.F.A. Carnegie Mellon ; Carnegie Mellon, 1985—.

CATHERINE MOORE, Associate Teaching Professor, Movement — M.F.A. University of Cincinnati, College-Conservatory of Music; Carnegie Mellon, 2000 —.

ANNE MUNDELL, Associate Professor, Design; Option Coordinator, Design — M.F.A. Brandeis University; Carnegie Mellon, 1989—.

JOE PINO, Assistant Professor, Sound Design – M.F.A., University of Virginia; Carnegie Mellon, 1999 –

SHIRLEY SALDAMARCO, Senior Special Lecturer, Drama.

TINA SHACKLEFORD, Associate Teaching Professor, Stage Management – M.F.A. University of California, San Diego; Carnegie Mellon, 2004 –

NARELLE SISSONS, Assistant Professor, Design - Central/St Martin's and The Royal College of Art in London, UK, ; Carnegie Mellon, 2007 –

INGRID SONNICHSEN, Associate Teaching Professor, Acting — M.A. Wayne State University, Carnegie Mellon, 1995—.

MILAN STITT, Professor, Dramatic Writing, Option Coordinator, Graduate Dramatic Writing — M.F.A., Yale University; Carnegie Mellon, 1997—.

SUSAN TSU, Professor, Costume Design — M.F.A. Carnegie Mellon, 2003—

DON WADSWORTH, Professor, Voice & Speech — M.F.A., University of Pittsburgh; Carnegie Mellon, 1989—.

KAF WARMAN, Associate Teaching Professor, Movement — M.F.A., Goddard College, Ecole

The School of Music

Noel Zahler, Head
Office: The College of Fine Arts 105

The School of Music at Carnegie Mellon employs the best aspects of conservatory training set within a great university, combining preparation for a lifetime in performance or composition with the advantages of learning in an intense academic environment. The School of Music is an accredited institutional member of the National Association of Schools of Music.

Each student is challenged to develop as a performer through individual instruction with master teachers. The School's relationship with the renowned Pittsburgh Symphony is among the strongest conservatory-symphony orchestra relationships in the United States, and Pittsburgh's uniquely strong sense of musical community fosters close relationships with the Pittsburgh Opera, Opera Theater, Chamber Music Society, Ballet, Mendelssohn Choir, and a host of other professional musical organizations. All teaching is entrusted to professional faculty — there are no assistant studio teachers or doctoral teaching fellows — and specialists in Musicology, Theory, Counterpoint, Analysis, Composition, Computer Music, Eurhythmics, Solfege, Music Education, Pedagogy, Accompanying and Coaching, Acting and Movement, Diction, Literature and Repertoire, Baroque Music, Chamber Music, Jazz, Conducting, and Recording Science provide a broad and rich platform for comprehensive performance preparation.

Regular performing ensembles include the Carnegie Mellon Philharmonic, Wind Ensemble, Concert Choir, Repertory Chorus, Baroque Ensemble, Contemporary Ensemble, Jazz Ensemble, Jazz Vocal Ensemble, Repertoire Orchestra, and Opera/Music Theater Production. Some of the School's ensembles are instrument specific: the Horn Choir and Percussion Ensemble, among others.

Every student in the School of Music is a performance or composition major. Opportunities for performance are stressed — undergraduate performance majors perform junior and senior recitals, all chamber music is juried, frequent opportunities on and off campus are provided, and community outreach is vigorously supported. At the same time, the university provides the greatest possible support for students combining their majors with minors in all disciplines, unique joint degree programs, and double major programs. These opportunities significantly increase a student's career options and marketability in the changing professional world of music.

The School of Music has an intense commitment to new music, led by its composition faculty, conductors who devote fully rehearsed cycles of the Philharmonic to works by student composers, studio faculty whose own performing careers regularly feature new works, regular performances of student works in almost every Contemporary Ensemble Program, frequent opportunities with the Wind Ensemble and Choirs, and inclusion on student recitals. The School's state-of-the-art recording facilities are an especially important resource for composers beginning their public careers.

Facilities

The teaching facilities of the School of Music are located on the ground, main, and mezzanine floors of the College of Fine Arts, on the first floor of Margaret Morrison Hall, and in Skibo Gymnasium. All teaching, rehearsal, and practice rooms are equipped with Steinway pianos. Music students also have access to a state-of-the-art recording studio and music technology cluster. Performances take place in Kresge Recital Hall, Carnegie Music Hall, and Alumni Concert Hall. The Hunt Library houses a fine collection of books, records, and scores. Listening and conference rooms are also available in the library.

School of Music Options

The School of Music offers a Bachelor of Fine Arts in the following areas:

- Performance (Instrumental, Voice, Piano, Organ)
- Composition

To earn a Bachelor's degree in either of these options, a candidate must satisfactorily fulfill all the requirements of the School of Music.

Within the options listed above students may elect specializations in the following areas:

- Dalcroze Eurhythmics Certificate
- Piano Pedagogy Certificate
- Accompanying Minor
- Conducting Minor
- Jazz Performance Minor
- Music Education Certification Minor
- Music Technology Minor

Dalcroze Eurhythmics Certificate

This program is designed to prepare teachers in the Dalcroze approach to music learning. The course of study includes eurhythmics, piano improvisation, and Dalcroze pedagogy. Carnegie Mellon undergraduates may enter the Dalcroze Training Program during their junior year. However, the certificate will be granted only upon completion of their undergraduate degree. This program is recommended particularly to students who would like to incorporate Dalcroze principles into their teaching and to those who want to obtain more experience in this field.

Piano Pedagogy Certificate

A two-year program leading to certification in piano pedagogy is open to current Carnegie Mellon piano majors and to pianists with bachelor's degrees. Piano and organ majors learn to teach piano in a closely supervised environment of class piano instruction. This program has received national acclaim as a model of excellence, with Carnegie Mellon children consistently capturing prestigious awards in national piano competitions.

Accompanying Minor

The accompanying minor consists of a six-semester sequence of courses designed to give the students experience with vocalists and instrumentalists, and it can include chamber music. There are individual coaching sessions as well as practical experience in vocal studios, dance studios, and instrumental studios.

Conducting Minor

This program is designed for students who are interested in acquiring conducting skills, in anticipation of either graduate study in conducting or a music education career. It includes required courses in basic conducting techniques for both choral and instrumental ensembles, orchestration, score reading/keyboard harmony, and elective courses in instrumental and vocal methods, diction, and literature and repertoire.

Jazz Performance Minor

With an emphasis on developing the "complete musician," all performance majors are encouraged to study jazz along with their classical training. Course offerings include Jazz Studio, two Jazz Ensembles, Jazz Vocal Ensemble, Jazz Piano, Jazz Chamber Music, Jazz Ear Training, Jazz Improvisation, Jazz Arranging, Jazz Composition, Jazz History, and Jazz Transcription and Analysis.

Music Education Certification Minor

Music Education Certification is a five-year program, with courses starting in the sophomore year. Bachelor of Fine Arts candidates who complete this program and pass the Praxis tests will receive Pennsylvania state certification in music (K-12), which is recognized in almost all other states.

Music Technology Minor

The student will take a series of courses which may include electronic and computer music, recording technology, the physics of sound, and computer programming. A rich computer music research environment enables talented students to work as programmers with outstanding faculty researchers, whose current projects are gaining international recognition in the areas of computer music and artificial intelligence.

Performances and Activities of the School of Music

The School of Music sponsors performances, master classes, and lectures by outstanding national and international guest artists. Announcements of faculty, student, and guest performances are released every month to the students and the community.

General Requirements for BFA Candidates

Candidates for the Bachelor of Fine Arts degree in composition are required to complete a composition for orchestra in their senior year. Candidates for the Bachelor of Fine Arts degree in performance are required to give public performances in their junior and senior years.

Candidates for the Bachelor of Fine Arts degree in applied areas other than piano are required to pass a piano proficiency test. Candidates for all School of Music degrees are required to pass four repertoire proficiency tests, and to participate in a major choral ensemble or major instrumental ensemble as assigned and to attend Convocation every semester of residence in the School of Music.

Music Curriculum

The music curriculum is based on the following five building blocks:

Studio
Theory
History
Ensemble
Academics

1. Studio — This is the heart of the school. Students receive individualized instruction with senior faculty in their major area of study: performance or composition.
2. Theory — These courses are designed to help students develop listening skills, to acquire theoretical knowledge, to recognize structural techniques and manipulate technological resources. It includes courses in sight-reading, ear-training, eurhythmics, harmony, contrapuntal techniques, analysis of musical forms, 20th century techniques, orchestration, score reading, and electronic and computer music for compositional and educational purposes. One music support course in the piano, organ, and instrumental curricula must be a theorycourse.
3. History - These courses cover in depth the music of the western world and survey the styles and musical structures of nonwestern music.
4. Ensemble — This area includes student participation in some of the following ensembles: Carnegie Mellon Philharmonic, Wind Ensemble, Concert Choir, Repertory Chorus, Baroque Ensemble, Contemporary Ensemble, Jazz Ensemble, Jazz Vocal Ensemble, Repertoire Orchestra, Opera/Music Theater Production, Horn Choir, Percussion Ensemble, and various chamber groups.
5. Academics — The School of Music requires one general studies course (outside of the School) per semester and six semesters of elective courses for graduation. These accumulated credits may be applied to minors or majors in other disciplines. Exceptional students in good academic and musical standing within the School are permitted to take additional courses beyond the number required for graduation. There is no charge for extra credits taken at Carnegie Mellon. One elective course in the piano, organ and instrumental curricula must be a literature, repertoire, and

pedagogy course.

Credits — The total number of units required for graduation is 399 for voice majors; 384 for composition majors; 372 for instrumental, organ, and piano majors. Three units equal one credit.

Piano		
First Year		
	Fall	Units
57-501	Studio	9
57-4xx	Major Ensemble	6
57-193	Skills of Accompanying I	3
57-152	Harmony I	6
57-161	Eurhythmics I	3
57-181	Solfège I	3
57-189	Repertoire and Listening for Musicians I	3
57-173	Survey of Western Music History	9
76-101	Interpretation and Argument	9
		51
	Spring	
57-501	Studio	9
57-4xx	Major Ensemble	6
57-194	Skills of Accompanying II	3
57-153	Harmony II	6
57-162	Eurhythmics II	3
57-182	Solfège II	3
57-190	Repertoire and Listening for Musicians II	3
64-100	Critical Histories of the Arts	9
57-101	Introduction to Music Technology	6
99-xxx	Computing @ Carnegie Mellon	3
		51
Second Year		
	Fall	Units
57-501	Studio	9
57-4xx	Major Ensemble	6
57-228	Chamber Music	3
57-151	Principles of Counterpoint	6
57-163	Eurhythmics III	3
57-183	Solfège III	3
57-289	Repertoire and Listening for Musicians III	3
57-283	Music History I	9
xx-xxx	<i>General Studies Course</i>	6
		48
	Spring	
57-501	Studio	9
57-4xx	Major Ensemble	6
57-228	Chamber Music	3
57-408	Form and Analysis	6
57-164	Eurhythmics IV	3
57-184	Solfège IV	3
57-290	Repertoire and Listening for Musicians IV	3
57-284	Music History II	9
xx-xxx	<i>Elective</i>	6
		48
Third Year		
	Fall	Units
57-501	Studio	9
57-4xx	Major Ensemble	6
57-228	Chamber Music	3
57-xxx	<i>Music Support Course (Theory/History)</i>	12
xx-xxx	<i>General Studies Course</i>	9
xx-xxx	<i>Elective</i>	6
		45
	Spring	
57-501	Studio	9
57-4xx	Major Ensemble	6
57-228	Chamber Music	3
57-xxx	<i>Music Support Course (Theory/History)</i>	12
xx-xxx	<i>General Studies Course</i>	9
xx-xxx	<i>Elective</i>	6
		45
Fourth Year		
	Fall	Units
57-501	Studio	9
57-xxx	<i>Performance Elective</i>	9
57-xxx	<i>Music Support Course (Theory/History)</i>	12
xx-xxx	<i>General Studies Course</i>	9
xx-xxx	<i>Elective</i>	3
		42

	Spring		
57-501	Studio	9	
57-xxx	<i>Performance Elective</i>	9	
57-xxx	<i>Music Support Course (Theory/History)</i>	12	
xx-xxx	<i>General Studies Course</i>	9	
xx-xxx	<i>Elective</i>	3	
			42

**Organ
First Year**

	Fall	Units	
57-502	Studio	9	
57-4xx	Major Ensemble	6	
57-191	Keyboard Studies I	3	
57-152	Harmony I	6	
57-161	Eurhythmics I	3	
57-181	Solfege I	3	
57-189	Repertoire and Listening for Musicians I	3	
57-173	Survey of Western Music History	9	
76-101	Interpretation and Argument	9	

51

	Spring		
57-502	Studio	9	
57-4xx	Major Ensemble	6	
57-192	Keyboard Studies II	3	
57-153	Harmony II	6	
57-162	Eurhythmics II	3	
57-182	Solfege II	3	
57-190	Repertoire and Listening for Musicians II	3	
64-100	Critical Histories of the Arts	9	
57-101	Introduction to Music Technology	6	
99-xxx	Computing @ Carnegie Mellon	3	

51

Second Year

	Fall	Units	
57-502	Studio	9	
57-4xx	Major Ensemble	6	
57-291	Keyboard Studies III	3	
57-151	Principles of Counterpoint	6	
57-163	Eurhythmics III	3	
57-183	Solfege III	3	
57-289	Repertoire and Listening for Musicians III	3	
57-283	Music History I	9	
xx-xxx	<i>General Studies Course</i>	6	

48

	Spring		
57-502	Studio	9	
57-4xx	Major Ensemble	6	
57-292	Keyboard Studies IV	3	
57-408	Form and Analysis	6	
57-164	Eurhythmics IV	3	
57-184	Solfege IV	3	
57-290	Repertoire and Listening for Musicians IV	3	
57-284	Music History II	9	
xx-xxx	<i>Elective</i>	6	

48

Third Year

	Fall	Units	
57-502	Studio	9	
57-4xx	Major Ensemble	6	
57-459	Score Reading/Keyboard Harmony	6	
57-xxx	<i>Music Support Course (Theory/History)</i>	12	
xx-xxx	<i>General Studies Course</i>	9	
xx-xxx	<i>Elective</i>	3	

45

	Spring		
57-502	Studio	9	
57-4xx	Major Ensemble	6	
57-xxx	<i>Music Support Course (Theory/History)</i>	12	
xx-xxx	<i>General Studies Course</i>	9	
xx-xxx	<i>Elective</i>	9	

45

Fourth Year

	Fall	Units	
57-501	Studio	9	
57-4xx	Major Ensemble	6	
57-xxx	<i>Performance Elective</i>	3	
57-xxx	<i>Music Support Course (Theory/History)</i>	12	
xx-xxx	<i>General Studies Course</i>	9	
xx-xxx	<i>Elective</i>	3	

42

	Spring		
57-502	Studio	9	
57-4xx	Major Ensemble	6	
57-xxx	<i>Performance Elective</i>	3	
57-xxx	<i>Music Support Course (Theory/History)</i>	12	
xx-xxx	<i>General Studies Course</i>	9	
xx-xxx	<i>Elective</i>	3	

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Voice

A voice major must also complete an advanced language course of at least 9 units. Recommended: a domestic or international program, after the sophomore year, which includes intensive study for credit in the Italian, German, or French language.

First Year

	Fall	Units	
57-500	Studio	9	
57-417	Major Ensemble	6	
57-191	Keyboard Studies I	3	
57-152	Harmony I	6	
57-161	Eurhythmics I	3	
57-181	Solfege I	3	
82-161	Elementary Italian I	12	
52-221	Italian Diction	3	
57-111	Movement and Dance I	3	
57-239	Acting I	6	

54

	Spring		
57-500	Studio	9	
57-417	Major Ensemble	6	
57-192	Keyboard Studies II	3	
57-153	Harmony II	6	
57-162	Eurhythmics II	3	
57-182	Solfege II	3	
57-431	Literature and Repertoire (Italian)	3	
57-112	Movement and Dance II	3	
57-240	Acting II	6	
76-101	Interpretation and Argument	9	
99-xxx	Computing @ Carnegie Mellon	3	

54

Second Year

	Fall	Units	
57-500	Studio	9	
57-417	Major Ensemble	6	
57-291	Keyboard Studies III	3	
57-163	Eurhythmics III	3	
57-183	Solfege III	3	
57-189	Repertoire and Listening for Musicians I	3	
57-173	Survey of Western Music History	9	
82-121	Elementary German I	12	
57-223	German Diction	3	
57-211	Movement and Dance III	3	
57-339	Acting III	6	

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	Spring		
57-500	Studio	9	
57-417	Major Ensemble	6	
57-292	Keyboard Studies IV	3	
57-164	Eurhythmics IV	3	
57-184	Solfege IV	3	
57-190	Repertoire and Listening for Musicians II	3	
64-100	Critical Histories of the Arts	9	
57-435	Literature and Repertoire (German)	3	
57-212	Movement and Dance IV	3	
57-340	Acting IV	6	
57-101	Introduction to Music Technology	6	

54

Third Year

	Fall	Units
57-500	Studio	9
57-417	Major Ensemble	6
57-xxx	Production Course	6
57-151	Principles of Counterpoint	6
57-289	Repertoire and Listening for Musicians III	3
57-283	Music History I	9
82-101	Elementary French I	12
57-222	French Diction	3

54

	Spring	Units
57-500	Studio	9
57-417	Major Ensemble	6
57-xxx	Production Course	6
57-408	Form and Analysis	6
57-290	Repertoire and Listening for Musicians IV	3
57-284	Music History II	9
57-432	Literature and Repertoire (French)	3

42

Fourth Year

	Fall	Units
57-500	Studio	9
57-417	Major Ensemble	6
57-xxx	Production Course	6
57-220	English Diction	3
57-434	Literature and Repertoire (MT)	3
xx-xxx	<i>Elective</i>	6

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	Spring	Units
57-500	Studio	9
57-417	Major Ensemble	6
57-xxx	Production Course	6
57-436	Literature and Repertoire (English/Contemporary)	3
57-434	Literature and Repertoire (MT)	3
xx-xxx	<i>Elective</i>	6

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Instrumental

First Year

	Fall	Units
57-xxx	Studio	9
57-4xx	Major Ensemble	6
57-189	Repertoire and Listening for Musicians I	3
57-191	Keyboard Studies I	3
57-152	Harmony I	6
57-161	Eurhythmics I	3
57-181	Solfege I	3
57-173	Survey of Western Music History	9
76-101	Interpretation and Argument	9

51

	Spring	Units
57-xxx	Studio	9
57-4xx	Major Ensemble	6
57-192	Keyboard Studies II	3
57-153	Harmony II	6
57-162	Eurhythmics II	3
57-182	Solfege II	3
57-190	Repertoire and Listening for Musicians II	3
64-100	Critical Histories of the Arts	9
57-101	Introduction to Music Technology	6
99-xxx	Computing @ Carnegie Mellon	3

51

Second Year

	Fall	Units
57-xxx	Studio	9
57-4xx	Major Ensemble	6
57-291	Keyboard Studies III	3
57-151	Principles of Counterpoint	6
57-163	Eurhythmics III	3
57-183	Solfege III	3
57-289	Repertoire and Listening for Musicians III	3
57-283	Music History I	9
xx-xxx	<i>General Studies Course</i>	6

48

Spring

57-xxx	Studio	9
57-4xx	Major Ensemble	6
57-292	Keyboard Studies IV	3
57-164	Eurhythmics IV	3
57-184	Solfege IV	3
57-290	Repertoire and Listening for Musicians IV	3
57-284	Music History II	9
57-408	Form and Analysis	6
xx-xxx	<i>Elective</i>	6

48

Third Year

	Fall	Units
57-xxx	Studio	9
57-4xx	Major Ensemble	6
57-228	Chamber Music	3
57-xxx	Music Support Course (Theory/History)	12
xx-xxx	<i>General Studies Course</i>	9
xx-xxx	<i>Elective</i>	6

45

Spring

57-xxx	Studio	9
57-4xx	Major Ensemble	6
57-228	Chamber Music	3
57-xxx	Music Support Course (Theory/History)	12
xx-xxx	<i>General Studies Course</i>	9
xx-xxx	<i>Elective</i>	6

45

Fourth Year

	Fall	Units
57-501	Studio	9
57-4xx	Major Ensemble	6
57-228	Chamber Music	3
57-xxx	Music Support Course (Theory/History)	12
xx-xxx	<i>General Studies Course</i>	9
xx-xxx	<i>Elective</i>	3

42

Spring

57-501	Studio	9
57-4xx	Major Ensemble	6
57-228	Chamber Music	3
57-xxx	Music Support Course (Theory/History)	12
xx-xxx	<i>General Studies Course</i>	9
xx-xxx	<i>Elective</i>	3

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Composition

First Year

	Fall	Units
57-521	Studio	9
57-4xx	Major Ensemble	6
57-191	Keyboard Studies I	3
57-152	Harmony I	6
57-161	Eurhythmics I	3
57-181	Solfege I	3
57-189	Repertoire and Listening for Musicians I	3
57-173	Survey of Western Music History	9
76-101	Interpretation and Argument	9

51

Spring

57-521	Studio	9
57-4xx	Major Ensemble	6
57-192	Keyboard Studies II	3
57-153	Harmony II	6
57-162	Eurhythmics II	3
57-182	Solfege II	3
57-190	Repertoire and Listening for Musicians II	3
64-100	Critical Histories of the Arts	9
57-101	Introduction to Music Technology	6
99-xxx	Computing @ Carnegie Mellon	3

51

Second Year

	Fall	Units
57-521	Studio	9
57-4xx	Major Ensemble	6
57-291	Keyboard Studies III	3
57-151	Principles of Counterpoint	6
57-163	Eurhythmics III	3
57-183	Solfege III	3

57-289	Repertoire and Listening for Musicians III	3
57-283	Music History I	9
57-258	20th Century Techniques	6
		48
Spring		
57-521	Studio	9
57-4xx	Major Ensemble	6
57-292	Keyboard Studies II	3
57-164	Eurhythmics IV	3
57-184	Solfege IV	3
57-290	Repertoire and Listening for Musicians IV	3
57-284	Music History II	9
57-257	Orchestration I for Composers	6
		48
Third Year		
		Units
Fall		
57-521	Studio	9
57-xxx	<i>Performance Elective</i>	3
57-332	Introduction to Conducting	6
57-271	Orchestration II for Composers	6
57-347	Music Technology I	6
57-xxx	<i>Music Support Course (Theory/History)</i>	6
xx-xxx	<i>General Studies Course</i>	9
xx-xxx	<i>Elective</i>	9
		54
Spring		
57-521	Studio	9
57-xxx	<i>Performance Elective</i>	3
57-336	Instrumental/Choral Conducting	6
57-348	Music Technology II	6
57-xxx	<i>Music Support Course (Theory/History)</i>	6
xx-xxx	<i>General Studies Course</i>	9
xx-xxx	<i>Elective</i>	3

		48
Fourth Year		
		Units
Fall		
57-521	Studio	9
57-4xx	Major Ensemble	6
57-459	Score Reading/Keyboard Harmony	6
57-xxx	<i>Music Support Course (Theory/History)</i>	6
xx-xxx	<i>General Studies Course</i>	12
xx-xxx	<i>Elective</i>	6
		45
Spring		
57-521	Studio	9
57-4xx	Major Ensemble	6
57-349	Supervised Theory Teaching	6
57-xxx	<i>Music Support Course (Theory/History)</i>	6
xx-xxx	<i>General Studies Course</i>	12
xx-xxx	<i>Elective</i>	6

		45
Dalcroze Eurhythmics Certificate 24 Units		
57-465	Eurhythmics Applications for Perf. and Teach.	3
57-466	Eurhythmics Applications for Perf. and Teach.	3
57-691/692	Dalcroze Pedagogy/Practice Teaching	6
57-350	Dalcroze Piano Improvisation	6
xx-xxx	Creative Movement/Choreography	3
57-641/642	Dalcroze Research Paper	3

Piano Pedagogy Certificate 30 Units		
57-273	Piano Pedagogy I	6
57-274	Piano Pedagogy II	6
57-275	Piano Pedagogy III	6
57-276	Piano Pedagogy IV	6
57-429	Beginning Piano for Children	6

Minor in Accompanying for Piano Majors in the School of Music

Admission Requirements:

The student must apply to enter the program in the office of the Director of Student Services (CFA 108).

Required Courses		36 units
57-381	Accompanying I	6
57-382	Accompanying II	6
57-383	Accompanying III	6
57-384	Accompanying IV	6
57-385	Accompanying V	6
57-386	Accompanying VI	6
Electives		18 units
(choose from the following courses)		
57-202	Opera History	9
57-220	English Diction	3
57-221	Italian Diction	3
57-222	French Diction	3
57-223	German Diction	3
57-332	Introduction to Conducting	6
57-336	Instrumental/Choral Conducting	6
57-431	Italian Literature and Repertoire	3
57-432	French Literature and Repertoire	3
57-433	Musical Theatre Literature and Repertoire	3
57-434	Musical Theatre Literature and Repertoire	3
57-435	German Literature and Repertoire	3
57-436	English/Contemporary Literature and Repertoire	3
57-459	Score Reading/Keyboard Harmony	6
57-607	Vocal Methods	3

Minimum units required for Accompanying Minor: 54

Minor in Conducting for Students in the School of Music

Admission Requirements:

1. The student must apply to enter the program in the office of the Director of Student Services (CFA 108) and have an interview with a member of the conducting faculty.
2. A 3.0 cumulative overall QPA and good academic standing are required for acceptance into the minor in conducting. Note that only a limited number of students can be accepted into the program.
3. In addition to the prerequisite courses listed below, the student must display superior solfege skills, by completing Advanced Solfege I and II with "A" or "B" grades or by demonstrating the equivalent level of skills.
4. Introduction to Conducting and Instrumental/Choral Conducting must be completed during the sophomore year with "A" grades before the student can register for the advanced conducting courses.
5. Conducting Practicum must be taken during the same semester as Independent Study in Conducting.
6. A 3.0 cumulative overall QPA is required for graduation with the minor in conducting

Prerequisite Courses		36 units
57-152	Harmony I	6
57-153	Harmony II	6
57-161	Eurhythmics I	3
57-162	Eurhythmics II	3
57-173	Survey of Western Music History	9
57-189	Repertoire and Listening for Musicians I	3
57-191	Keyboard Studies I	3
57-192	Keyboard Studies II	3

Corequisite Course for Voice Majors		6 units
57-151	Principles of Counterpoint	6

Required Courses		45 units
57-332	Introduction to Conducting	6
57-336	Instrumental/Choral Conducting	6
57-408	Form and Analysis	6
57-257	Orchestration I	6
57-271	Orchestration II	6
57-459	Score Reading/Keyboard Harmony	6
57-364	Conducting Practicum	3
57-618	Independent Study in Conducting	6

Electives 12 units
(choose from the following courses)

57-220	English Diction	3
57-221	Italian Diction	3
57-222	French Diction	3
57-223	German Diction	3
57-258	20th Century Techniques	6
57-337	Sound Recording	6
57-338	Sound Editing and Mastering	6
57-360	Brass Methods	3
57-363	String Methods	3
57-431	Literature and Repertoire (Italian)	3
57-432	Literature and Repertoire (French)	3
57-435	Literature and Repertoire (German)	3
57-450	Jazz Ear Training	3
57-607	Vocal Methods	3
57-225	Contemporary Ensemble	3
57-227	Jazz Ensemble	3
57-228	Chamber Music	3
57-328	Jazz Chamber Music	3

Minimum units required for Conducting minor: 57

Minor in Jazz Performance for Students in the School of Music

Admission Requirements:

1. The student must apply to enter the program in the office of the Director of Student Services (CFA 108).
2. The student must perform an acceptable audition. For the audition, the student should perform two contrasting pieces and demonstrate the potential for the development of improvisatory skills.

Prerequisite Courses 9 units

57-152	Harmony I	6
57-181	Solfege I	3

Required Jazz Courses 24 units

57-xxx	Jazz Ensemble or Jazz Vocal Ensemble	3
57-xxx	Jazz Ensemble or Jazz Vocal Ensemble	3
57-319	Jazz Piano	3
57-320	Jazz Piano	3
57-328	Jazz Chamber Music	3
57-328	Jazz Chamber Music	3
57-450	Jazz Ear Training	3
57-453	Jazz Improvisation	3

Required Studio Courses 24 units

57-496	Minor Studio	6
57-497	Minor Studio	6
57-498	Minor Studio	6
57-499	Minor Studio	6

Elective Courses (choose 1) 6 units

57-451	Jazz Arranging	6
57-452	Jazz Composition	6
57-454	Jazz Transcription and Analysis	6
57-457	Jazz History I	6
57-458	Jazz History II	6

Minimum units required for Jazz Performance Minor: 54

Minor in Music Education for Students in the School of Music

Admission Requirements:

1. The student should apply to the music education faculty no earlier than spring of the freshman year.

Corequisite General Courses 45 units

21-xxx	Mathematics Course #1	9
21-xxx	Mathematics Course #2	9
76-xxx	English Literature Course	9
85-xxx	Developmental Psychology Course	9
85-xxx	Educational Psychology Course	9

Corequisite Music Courses 18 units

57-391	Keyboard Studies	3
57-392	Keyboard Studies	3
57-393	Keyboard Studies Test (music education)	0
57-332	Introduction to Conducting	6
57-336	Instrumental/Choral Conducting	6

General Education Courses 18 units

57-331	Principles of Education	9
xx-xxx	Professional Education Course	9

Music Education Methods Courses 45 units

General Methods Courses		
57-375	Music in the Elementary School	6
57-356	Elementary Guided Teaching	3
57-376	Music in the Secondary School	6
57-355	Secondary Guided Teaching	3

Applied Area Methods Courses		
57-607	Vocal Methods	3
57-360	Brass Methods	3
57-361	Pecussion Methods	3
57-362	Woodwind Methods	3
57-363	String Methods	3
57-207	Secondary Studio (fretted instrument)	3

Band Methods Courses		
57-334	Fundamentals of Marching Band	3
57-331	Band and Choral Arranging	6

Music Education Teaching Courses 15 units

57-608	Observation	3
57-603	Practice Teaching (elementary)	6
57-604	Practice Teaching (secondary)	6

Minimum units required for Music Education Minor: 78

Minor in Music Technology for Students in the School of Music

Admission Requirements:

1. The student must apply to enter the program in the office of the Director of Student Services (CFA 108).

Prerequisite Course 3 units

Computing @ Carnegie Mellon must be passed before taking any of the required technology courses.

99-xxx	Computing @ Carnegie Mellon	3
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Introductory Music Courses 18 units

57-152	Harmony I	6
57-173	Survey of Western Music History	9
57-189	Repertoire and Listening for Musicians I	3

Required Music Technology Courses 33 units

57-101	Introduction to Music Technology	6
57-337	Sound Recording	6
57-338	Sound Editing and Mastering	6
57-347	Electronic and Computer Music	6
57-438	Multitrack Recording	9

Technical Courses (Choose 2) 15 units

Other technical courses may also be approved by the advisor for music minors.

xx-xxx	H&SS Multimedia Course	9
15-100	Introductory/Intermediate Programming	10
15-229	MultiMedia Programming and Computer Science	9
33-114	Physics of Musical Sound	9

54-165	Sound Design I	6
57-610	Internship	9
Minimum units required for Music Technology Minor:		66

Minor in Music Performance/Music (Composition) for Students in the School of Music

Admission Requirements:

1. The student must apply to enter the program in the office of the Director of Student Services (CFA 108).
2. The student must perform an acceptable audition. Requirements for the audition can be found in the Admission section of the Undergraduate Catalog.

Corequisite Courses 24 units

57-161	Eurhythmics I	3
57-181	Solfège I	3
57-152	Harmony I	6
57-173	Survey of Western Music History	9
57-189	Repertoire and Listening for Musicians I	3

Required Studio Courses 24 units

57-496	Minor Studio	6
57-497	Minor Studio	6
57-498	Minor Studio	6
57-499	Minor Studio	6

Required Language Courses (Voice Minors) 18 units

Language Course (Choose 1)

82-101	Elementary French I	12
82-121	Elementary German I	12
82-161	Elementary Italian I	12

Diction Course (Choose 1)

57-221	Italian Diction	3
57-222	French Diction	3
57-223	German Diction	3

Literature and Repertoire Course (Choose 1)

An introductory course in the applicable language is a prerequisite for each of these courses.

57-431	Italian Literature and Repertoire	3
57-432	French Literature and Repertoire	3
57-435	German Literature and Repertoire	3

Minimum Units Required: 24-42

Faculty

TIMOTHY ADAMS, Associate Professor of Percussion — Carnegie Mellon, 1995—.

DOUGLAS AHLSTEDT, Associate Professor of Voice — M.M., Eastman School of Music; Carnegie Mellon, 1998—.

ALBERTO ALMARZA, Associate Professor of Flute — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1991—.

DONNA AMATO, Staff Accompanist and Artist Lecturer in Piano — Carnegie Mellon, 1998—.

EFRAIN AMAYA, Artist Lecturer in Music Theory and Resident Conductor — Carnegie Mellon, 1993—.

TOBY APPEL, Artist Lecturer in Viola — Curtis Institute of Music; Carnegie Mellon, 2002—.

LEONARDO BALADA, University Professor of Composition; University Professor — Diploma, The Juilliard School of Music; Carnegie Mellon, 1970—.

JEANNE BAXTRESSER, Vira I. Heinz Professor of Flute; University Professor — B.M., The Juilliard School of Music; Carnegie Mellon, 1997—.

SCOTT BELL, Artist Lecturer in Oboe — Carnegie Mellon, 1994—.

NEAL BERTSEN, Artist Lecturer in Trumpet — Carnegie Mellon, 2003—.

RAY BLACKWELL, Staff Accompanist / Vocal Coach — Carnegie Mellon, 2003—.

IRENE BRYCHIN, Artist Lecturer in Clarinet — Carnegie Mellon, 1995—.

WILLIAM CABALLERO, Artist Lecturer in Horn — Carnegie Mellon, 2007—.

JUDITH CAGLEY, Artist Lecturer in Solfège — Carnegie Mellon, 2006—.

CHRISTOPHER CAPIZZI, Artist Lecturer in Jazz Piano — Carnegie Mellon, 2004—.

ANDRES CARDENES, Dorothy Richard Starling and Alexander Speyer, Jr. University Professor of Violin; University Professor — Carnegie Mellon, 1989—.

MARIA CARUSO, Artist Lecturer in Alexander Technique — Carnegie Mellon, 2003—.

L. MARK CARVER, Associate Teaching Professor of Coaching and Accompanying — M.M., Carnegie Mellon University; Carnegie Mellon, 1995—.

REBECCA CHERIAN, Artist Lecturer in Trombone — Carnegie Mellon, 1993—.

DENIS COLWELL, Associate Professor, Conductor of Wind Ensemble — Carnegie Mellon, 1980—.

JENNIFER CONNER, Artist Lecturer in Chamber Music — Carnegie Mellon, 2005—.

RICHARD COWAN, Assistant Professor of Voice — Carnegie Mellon, 2008—.

MURRAY CREWE, Artist Lecturer in Bass Trombone — Carnegie Mellon, 2001—.

CYNTHIA DE ALMEIDA, Artist Lecturer in Oboe — M.M., Temple University; Carnegie Mellon, 1991—.

MICHELE DE LA REZA, Lecturer in Dance — Carnegie Mellon, 2007—.

ERIC DEFADE, Artist Lecturer in Jazz Saxophone — Carnegie Mellon, 2002—.

MARK DOMENCIC, Artist Lecturer in Music Theory — Carnegie Mellon, 2007—.

THOMAS DOUGLAS, Associate Teaching Professor of Voice, Director of Jazz Vocal Ensemble— M.M., Duquesne University; Carnegie Mellon, 1991—.

PAUL EVANS, Artist Lecturer in Percussion — Carnegie Mellon, 1995—.

JAMES FERLA, Artist Lecturer in Guitar — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1977—.

CYRUS FOROUGH, Professor of Violin — Carnegie Mellon, 2001—.

NANCY GALBRAITH, Professor of Composition — M.M., West Virginia University; Carnegie Mellon, 1984—.

PAUL GERLACH, Artist Lecturer in Music Education — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1982—.

ALASDAIR GILLIES, Artist Lecturer in Bagpipes, Director of Bagpipe Band — Pipe Majors Certificate, Army School of Bagpipe Music; Carnegie Mellon, 1997—.

MARY BETH GLASGOW SCHOTTING, Artist Lecturer in Violin — Carnegie Mellon, 1998—.

NANCY GOERES, Artist Lecturer in Bassoon — B.M., Boston University; Carnegie Mellon, 1988—.

ENRIQUE GRAF, Artist Lecturer in Piano — Carnegie Mellon, 1996—.

SIDNEY HARTH, Artist Lecturer in Violin — Carnegie Mellon, 2000—.

ROSEANNA IRWIN, Associate Teaching Professor of Coaching and Accompanying — M.M., Duquesne University; Carnegie Mellon, 1990—.

CARL JACKSON, Artist Lecturer in Jazz Trombone — Carnegie Mellon, 1992—.

PAUL JOHNSTON, Artist Lecturer in Music — Carnegie Mellon, 2005—.

ANNABELLE JOSEPH, Professor of Music — D.A., Carnegie Mellon University; Carnegie Mellon, 1986—.

KENNETH KEELING, Professor of Music — D.M.A., Catholic University of America; Carnegie Mellon, 1996—.

CRAIG KNOX, Artist Lecturer in Tuba — Carnegie Mellon, 2005—.

PETER KOPE, Lecturer in Dance — Carnegie Mellon, 2007—.

LANCE LADUKE, Artist Lecturer in Euphonium — Carnegie Mellon, 2003—.

CARLA LAROCCA, Lecturer in Keyboard Studies — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1991—.

ELIZABETH LAWRENCE, Artist Lecturer in Jazz Voice — Carnegie Mellon, 1996—.

ROBERT LAUVER: ARTIST LECTURER IN HORN — CARNEGIE MELLON, 2007—.

GREGORY LEHANE, Professor of Drama and Music — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1991—.

HANNA WU LI, Professor of Piano and Piano Pedagogy — M.M., Northwestern University; Carnegie Mellon, 1969—.

MARIE LIBAL-SMITH, Accompanist — M.M., Indiana University; Carnegie Mellon, 2002—.

ANTHONY LORING MCKAY, Professor of Drama — B.F.A., Carnegie Mellon University; Carnegie Mellon, 1985—.

LUZ MANRIQUEZ, Associate Teaching Professor of Coaching and Accompanying — Carnegie Mellon, 1992—.

JOHN MARCINIZYN, Artist Lecturer in Guitar — Ph.D., University of Pittsburgh; Carnegie Mellon, 1991—.

WALTER MORALES, Assistant Director of Orchestral Studies — Carnegie Mellon, 2002—.

STEPHEN NEELY, Artist Lecturer in Eurhythmics, Director of School of Music Pre-College Programs — M.M., Carnegie Mellon University; Carnegie Mellon, 1998—.

JOSEPH NEGRI, Artist Lecturer in Jazz Guitar — B.F.A., Carnegie Mellon University; Carnegie Mellon, 1988—.

RODRIGO OJEDA, Staff Accompanist — Carnegie Mellon, 2003—.

BENJAMIN OPIE, Artist Lecturer in Music Technology — Carnegie Mellon, 2005—.

NATALIE OZEAS, Associate Head and Professor of Music Education — Ed. D., University of Pittsburgh; Carnegie Mellon, 1989—.

ROBERT PAGE, Paul Mellon Professor of Music and Director of Choral and Opera Studies — M.M., Indiana University; Carnegie Mellon, 1976—.

PHILIP PANDOLFI, Artist Lecturer in Bassoon — Carnegie Mellon, 1995—.

DAVID PELLOW, Director of Jazz Studies — M.M., Duquesne University; Carnegie Mellon, 1991—.

MILDRED MILLER POSVAR, Artist Lecturer in Voice — Carnegie Mellon, 1981—.

DAVID PREMO, Artist Lecturer in Cello — Carnegie Mellon, 1994—.

RICHARD RANDALL, Assistant Professor of Music Theory — Carnegie Mellon, 2008—.

KAREN ROETHLISBERGER, Staff Accompanist/Vocal Coach — Carnegie Mellon, 2004—.

MICHAEL RUSINEK, Artist Lecturer in Clarinet — Carnegie Mellon, 1998—.

VAHAN SARGSYGAN, Staff Accompanist — Carnegie Mellon, 2005—.

SERGEY SCHEPKIN, Associate Professor of Piano — Carnegie Mellon, 2003—.

RICCARDO SCHULZ, Associate Teaching Professor and Director of Recording Activities — M.A., University of Pittsburgh; Carnegie Mellon, 1988—.

STEPHEN SCHULTZ, Associate Teaching Professor of Music History, Conductor of CMU Baroque — Carnegie Mellon, 2002—.

FRANCO SCIANNAMEO, College Distinguished Scholar in Multidisciplinary Studies — D.M., Accademia Nazionale di Santa

Cecilia; Carnegie Mellon, 1990—.

LEWIS STROUSE, Associate Teaching Professor of Music Education— D.A., Ball State University; Carnegie Mellon, 1992—.

PETER SULLIVAN, Artist Lecturer in Trombone — Carnegie Mellon, 2000—.

MARILYN TAFT THOMAS, Professor of Music — Ph.D., University of Pittsburgh; Carnegie Mellon, 1981—.

THOMAS THOMPSON, Associate Teaching Professor of Clarinet — M.M., Northwestern University; Carnegie Mellon, 1986—.

STEPHEN TOTTER, Artist Lecturer in Voice — Carnegie Mellon, 1994—.

JEFFREY TURNER, Artist Lecturer in String Bass — Carnegie Mellon, 1989—.

REZA VALI, Associate Professor of Composition — Ph.D., University of Pittsburgh; Carnegie Mellon, 1988—.

GRETCHEN VAN HOESEN, Artist Lecturer in Harp — M.M., The Juilliard School; Carnegie Mellon, 1985—.

LAURA KNOOP VERY, Assistant Professor of Voice — Carnegie Mellon, 2008—.

GEORGE VOSBURGH, Artist Lecturer in Trumpet — Carnegie Mellon, 2003—.

BILLIE JO MILLER WARD, Staff Accompanist — Carnegie Mellon, 1996—.

GLENN WAYLAND, Artist Lecturer in Jazz Trombone — Carnegie Mellon, 1989—.

JAMES WHIPPLE, Artist Lecturer in Theory — Carnegie Mellon, 1995—.

COLETTE JOUSSE WILKINS, Artist Lecturer in Solfege — First Prize, Conservatoire National de Versailles, France; Carnegie Mellon, 1974—.

DONALD WILKINS, Professor Emeritus of Organ — First Prize Paris Conservatory, Fellow American Guild of Organists, M.A., Harvard University; Carnegie Mellon, 1966—.

ANNE MARTINDALE WILLIAMS, Artist Lecturer in Cello — Diploma, Curtis Institute of Music; Carnegie Mellon, 1987—.

JOHN WILSON, Artist Lecturer in Jazz History/Jazz Trumpet — Carnegie Mellon, 2001—.

NOEL ZAHLER, Head and Professor of Music — Carnegie Mellon, 2007—.

CLARA ZAHLER, Associate Teaching Professor in Music Education — Carnegie Mellon, 2007—.

ISAIAS ZELKOWICZ, Artist Lecturer in Viola — M.M., The Juilliard School; Carnegie Mellon, 1981—.



The College of Humanities and Social Sciences



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The College of Humanities and Social Sciences

John P. Lehoczy, Dean
 Kristina Straub, Associate Dean
 Joseph E. Devine, Associate Dean for Undergraduate Studies
 H&SS Academic Advisory Center: Baker Hall A57
www.hss.cmu.edu/

The College of Humanities and Social Sciences (H&SS) is one of Carnegie Mellon's seven principal colleges. The College consists of the departments of Economics, English, History, Modern Languages, Philosophy, Psychology, Social and Decision Sciences, Statistics, and a college-wide interdisciplinary program in Information Systems. The College accounts for approximately one-fifth of the university's undergraduate population; 80% of the college's students are undergraduates. The college is staffed by 180 full-time faculty. Like its counterparts in engineering, science, computer science, business, and the fine arts, the College has three primary thrusts: undergraduate education, graduate education, and research or creative pursuits. Thus, the College shares in the University's identity as an institution that merges first-rate, innovative research and creativity with undergraduate education. All faculty engage in both teaching and research or creative work. Undergraduates, thus, benefit from contact in the classroom with highly accomplished faculty researchers and creative artists.

For example, beginning with the College's General Education (GenEd) program, H&SS students are taught by some of the College's most accomplished and senior faculty. They bring with them into the classroom a contagious excitement from their active involvement at the forefront of their fields. Freshmen also select from an array of freshman seminars in which students explore exciting and topical areas of study with regular faculty in small groups of no more than 15-20 students. Sophomores and second-semester freshmen may also select a "Faculty Research Training" course which involves them in a faculty research project. These freshman/sophomore features are complemented during the junior and senior years by small elective courses, the option of overseas study, seminars and project courses, and a range of undergraduate research options (including a senior honors program) that students can pursue with regular faculty.

Liberal/Professional Education

Edward Fiske, former Education Editor of The New York Times and author of the Fiske Guide to Colleges, has noted that the College and University have done "perhaps the most original thinking of any American university in pursuing the twin goals of liberal-professional education." In its belief that these two types of knowledge ("liberal" and "professional") are highly complementary, H&SS embraces a philosophy that has its roots in Carnegie Mellon's institutional origins: namely, that the traditional liberal arts disciplines merit close, rigorous study, while at the same time practical skills are also worthy of mastery, and of the most serious intellectual examination.

The College's educational program is liberal in that it stresses breadth and invites wide-ranging inquiry, both through its general education curriculum and through programs in the humanities, behavioral sciences, and social sciences; the "professional" dimension of the College's educational program derives from general emphases on analytical sophistication and application, and also from a subset of in-depth major programs which prepare students for specific career fields as well as for graduate or professional school training. The rationale for this liberal/professional approach stems from the premise that the intellectual foundations of a challenging liberal education and meaningful professional education are essentially the same. Knowledgeable and effective citizens are as much in need of broad intellectual perspectives, analytical skills, and problem-solving strategies as are most professionals. Moreover, as leaders in American higher education generally agree, undergraduate education is not well served if professional specialization in undergraduate programs is achieved prematurely. The challenge is to strike a balance between breadth and depth,

both within and outside of one's specialty. Such a balance insures versatility in one's profession and the knowledge and ability to keep pace as individuals and citizens with changes in our social, technical, and cultural environments. Thus, the objectives of both liberal and professional education can and should work in tandem to complement and enhance one another.

Degree Options

H&SS offers a large number and wide range of innovative, rigorous majors and a comparable number of minors. In addition, H&SS students may also apply for admission to one of a number of accelerated masters programs that result in both a bachelor's and master's degree. These options provide H&SS students with a great deal of flexibility and choice in designing a program of study.

H&SS Majors

Name of Major (Degree Options)	Department
Economics (B.A.)	Economics
Economics (B.S.)	Economics
English (B.A.)	English
Creative Writing (B.A.)	English
Professional Writing (B.A.)	English
Technical Writing and Communication (B.A.)	English
Anthropology and History (B.A. or B.S.)	History
History and Policy (B.A. or B.S.)	History
Social and Cultural History (B.A. or B.S.)	History
Economics and Statistics (B.S.)	Interdepartmental
Environmental Policy (additional major only)	Interdepartmental
Ethics, History, and Public Policy (B.A. or B.S.)	Interdepartmental
Information Systems (B.S.) (by admission)	Interdepartmental
Linguistics (B.A.)	Interdepartmental
Russian Studies (B.A.)	Interdepartmental
Student Defined (B.A. or B.S.)	Interdepartmental
Chinese (B.A.)	Modern Languages
French and Francophone Studies (B.A.)	Modern Languages
German (B.A.)	Modern Languages
Hispanic Studies (B.A.)	Modern Languages
Japanese (B.A.)	Modern Languages
Logic and Computation (B.S.)	Philosophy
Philosophy (B.A.)	Philosophy
Cognitive Science (B.S.)	Psychology
Psychology (B.A. or B.S.)	Psychology
Psychology and Biological Sciences (B.S.)	Psychology
Policy and Management (B.S.)	Social and Decision Sciences
Decision Science (B.S.)	Social and Decision Sciences
Global Politics (B.S.)	Social and Decision Sciences
Statistics (B.S.)	Statistics

Additional Majors

Many H&SS students pursue additional majors and/or minors in the college, and in some cases in other Carnegie Mellon colleges. An additional major refers to the completion of the full requirements for a major program in addition to those required for the primary major. In most cases, requirements for an additional major are the same as those for a primary major. Minors are like majors in that they consist of coherent programs of study in a department, or across departments. Minors differ from majors in the breadth and depth reflected in the number of courses required.

Most H&SS majors are available as additional majors; a few are available only as additional majors. Students from outside H&SS are also eligible to attain an additional major in H&SS programs that offer an additional major option. In such cases, non-H&SS students would be required to complete only those courses in the H&SS General Education (GenEd) program that are prerequisites to courses required for the H&SS major they are pursuing. A number of additional majors and minors elsewhere in the university are available to H&SS students.

Minors

In H&SS, there are two types of minors: departmental minors, which are housed in an H&SS academic department, and interdepartmental minors, which are sponsored by more than one department and administered through the faculty advisor's academic department. H&SS minors are available to students from all colleges in the University.

Name of Minor	Department
African and African American Studies	Interdepartmental
Chinese	Modern Languages
Decision Science	Social and Decision Sciences
Economics	Economics
English	English
Environmental Studies	Interdepartmental
Ethics	Philosophy
European Studies	Interdepartmental
Film and Media Studies	Interdepartmental
French and Francophone Studies	Modern Languages
Gender Studies	Interdepartmental
German	Modern Languages
Global Politics	Social and Decision Sciences
Global Systems and Management	Interdepartmental
Health Care Policy and Management	Interdepartmental
Hispanic Studies	Modern Languages
History	History
Japanese	Modern Languages
Linguistics	Interdepartmental
Logic and Computation	Philosophy
Multimedia Production	Interdepartmental
Philosophy	Philosophy
Policy and Management	Social and Decision Sciences
Psychology	Psychology
Religious Studies	Interdepartmental
Russian Studies	Interdepartmental
Science, Technology and Society	Interdepartmental
Sociology	Interdepartmental
Statistics	Statistics
Student-Defined	Interdepartmental

Bachelor of Arts & Bachelor of Science

H&SS majors lead in some cases only to a Bachelor of Arts (B.A.) degree, in other cases only to a Bachelor of Science (B.S.) degree, and in some cases to a choice between a B.A. or a B.S. degree. B.A. degree programs usually require less course work in technical and/or quantitative disciplines, and more depth and breadth in various humanities and (in some cases) arts disciplines. In contrast, B.S. degrees are offered in areas requiring special technical, quantitative or scientific competencies.

H&SS General Education Program

Carnegie Mellon's educational legacy emphasizes the connection between theoretical knowledge and praxis: the university's interdisciplinary approach to education embraces the practical application and analysis of knowledge in institutional, social, and historical contexts. Carnegie Mellon graduates are excellent practitioners in their chosen fields. The General Education Program (GenEd) supports that expertise and ensures that students gain the well-informed perspectives necessary to grow and change with their professions, to interact wisely with the natural environment, and to be responsible and informed citizens in an increasingly technological world and a complex global culture.

Broad Aims

The GenEd program provides the integrative component to a Carnegie Mellon education and extends through the entire undergraduate experience. It sets crucial cornerstones and draws important connections among different facets of the students' education. Its distinctive emphases and directions foster intellectual curiosity and encourage students to gain: wide, historically informed appreciation of the arts and humanities and sciences, broad understanding of mathematics and the experimental method, critical openness to ethical reflection and social responsibility, and an acute global and environmental awareness.

It differs sharply from more traditional liberal arts or general education programs in its emphasis on integration, not only breadth. Its courses give students essential knowledge in academic disciplines, while encouraging them to connect fields and to think comparatively about the methods and materials constituting a field of knowledge. The integrative feature of the program goes beyond the purely academic and disciplinary: it asks students to reflect on their role as citizens in a world that crucially demands informed perspectives on social and international issues, diverse cultures, the natural environment, uses of technology, the allocation of human and material resources, and many other problems challenging our future.

Categories

To transcend narrow disciplinary confines, the program isolates five broad intellectual activities - exercised in almost all disciplines: Communicating, Reflecting, Modeling, Deciding and Creating. To indicate their primary or perhaps most striking applications, the activities are supplemented by indications of general subject areas. These activities together with the broad indications are the bases for categories, in which suitable courses are organized from all parts of the University. There are five categories:

1. Communicating: Language and Interpretations
2. Reflecting: Societies and Cultures
3. Modeling: Mathematics and Experiments
4. Deciding: Social Sciences and Values
5. Creating: Designs and Productions

The schematic framework highlights central features of an ideal learning environment and the University's intellectual core mission, which is seen as part of a broader human and social enterprise. These features have been identified because they are pervasive and by no means limited to the indicated areas; for example, communicating is crucial across all fields and reflecting is not restricted to thinking about societies and cultures. Students learn to communicate, reflect, model, decide, and create as crucial components of a whole, integrative educational experience:

students gain expertise in their chosen discipline and exercise the integrative skills within them.

The program includes a rich variety of courses. Some classes encourage students to explore a subject in a basic way, providing them with the key building blocks of knowledge in the particular subject. Others are designed to ask students explicitly to reflect on knowledge, to look at the building blocks from different disciplinary, social, or global perspectives in order to gain a deeper understanding of the arts, humanities, and sciences. Here are, more explicitly, the themes for the different categories.

Categories

1. Communicating: Language and Interpretations -
18 units minimum
(76-101 required in the 1st year)
2. Reflecting: Societies and Cultures -
18 units minimum
(79-104 required in the 1st year)
3. Modeling: Mathematics and Experiments –
27 units minimum
(9 from Mathematics, 9 units from Natural Science, 9 from any course listed in Modeling)
4. Deciding: Social Sciences and Values –
18 units minimum
(36-201 required in the 1st year)
5. Creating: Designs and Productions -
18 units minimum
6. Plus 18 additional units from any Category
7. Computing @ Carnegie Mellon – 3 units minimum
(99-101, 99-102 or 99-103 required in the 1st semester)
8. Freshman Seminar Requirement (FSR)
(completed in the 1st year)

Five courses are required to be completed in the 1st year: 76-101, 79-104, 36-201, Freshman Seminar Requirement (FSR) and Computing @ Carnegie Mellon (C@CM). The Freshman Seminar Requirement may not double count toward a GenEd Category or any other requirement (ex., majors, minors).

GenEd Category Courses

1. Communicating: Language and Interpretations (18 units)

Courses in this category give special attention to the study of language as interpretation, expression and argument within and across multiple discourses. Students examine language for its internal logics and structures. They also explore its rhetorical, historical, cultural, or philosophical dimensions, assessing how it functions while expanding their writing skills and sharpening their analytical abilities.

- 76-101 Interpretation and Argument – REQUIRED – 1st year
(various topics by section; go to the H&SS General Education Website for updated topics:
www.hss.cmu.edu/gened/)

Non-native English speakers who are placed into 76-100, Reading and Writing for an Academic Context (1st semester, 1st year) use this course as the second Category 1 course, but are also required to complete 76-101, Interpretation and Argument (2nd semester, 1st year). For updated lists of other “Communicating” courses, go to the H&SS General Education website (www.hss.cmu.edu/gened/).

2. Reflecting: Societies and Cultures (18 units)

This category emphasizes the study of history, society, and culture from local and global perspectives. Courses investigate contemporary societies as well as those of the past, along with their rich array of cultural products, artifacts, and ideas. They encourage a comparative and reflective approach to the understanding of the past and what it can bring to the constitution of present social relations and cultural outlooks.

79-104 Introduction to World History – REQUIRED – 1st year
For other course listings, visit the H&SS General Education website at www.hss.cmu.edu/gened/.

3. Modeling: Mathematics and Experiments (27 units)

Courses in this category stress the interplay of mathematical (formal) theories and experimental work. Some courses investigate the internal structure of theories, whereas others use them as models for producing real-world knowledge. Such models may be drawn from a variety of disciplines including the natural sciences, but also, for example, psychology and computer science. The interactions between theorizing and experimenting (observing) can be understood within an intellectual framework that invites comparative assessment.

- Mathematics (Required: complete 9 units)
- Natural Science (Required: complete 9 units)
- Other Modeling Courses

For updated course offerings, go to the H&SS General Education website at www.hss.cmu.edu/gened/.

4. Deciding: Social Sciences and Value (18 units)

The theme of this category is the exploration of cognitive, behavioral and ethical dimensions of decision-making on both the individual and social level. Making decisions requires a broad understanding of human rationality and social interaction. Some courses examine also the critical collection and analysis of data for achieving such an understanding, whereas others emphasize the historical development of policies and values, which form the matrix for decision-making.

36-201 Statistical Reasoning — REQUIRED

For updated course offerings, go to the H&SS General Education website at www.hss.cmu.edu/gened/.

5. Creating: Designs and Productions (18 units)

In the arts, the humanities, the sciences, and in engineering, it is essential to produce artifacts: ex., a painting, a poem, a musical performance, a piece of technology, the design of an experiment, or the proof of a mathematical theorem. Courses may center on the students’ creation of artifacts, but they may also analyze such creations by exploring creative processes at work within and across disciplines. Such explorations should be informed by a deep understanding of contexts of production and reception.

For updated course offerings, go to the H&SS General Education website at www.hss.cmu.edu/gened/.

6. Plus, TWO Additional GenEd Category courses (18 units)

These courses can be complete from any GenEd Category.

7. University Requirement (UR) (3 units)

This course is a 3 unit mini-course, pass/no credit, completed in the 1st semester.

99-101/102/103 Computing @ Carnegie Mellon

8. Freshman Seminar Requirement (FSR) (9 units)

This requirement ensures that all first year students entering H&SS have a small-group course experience in their first year. These seminars consist of substantive academic content drawn from the faculty members’ expertise, as well as providing a supportive environment for the enhancement of academic skills. Required of all first year H&SS students (to be completed in the first year) according to assignment by AAC Academic Advisor in the fall semester. For current seminar topics and course descriptions, go to the H&SS General Education Website at www.hss.cmu.edu/gened/.

College Services and Programs

The educational programs in H&SS are complemented by a number of services, special programs, centers, and computing facilities.

H&SS Academic Advisory Center

Office: Baker Hall A57
www.hss.cmu.edu/departments/deans_office/aac/default.html

The Academic Advisory Center (AAC) for the College of Humanities and Social Sciences is primarily responsible for monitoring the progress of H&SS students prior to entering a major program. As the "home base" for H&SS students, the AAC provides information, advice, and counsel about scheduling, the college's General Education (GenEd) program requirements, and the various majors and minors available. Most important, advisors also support students in making a successful transition to university life. The advisors consider this kind of information and advice to be vital for students adapting to a new and demanding environment, working their way through the H&SS GenEd Program, and preparing for various academic and professional choices to follow. The AAC is a walk-in center, although it is preferred that individual appointments be made. The Center's hours are 8:30 a.m. to 5:00 p.m., Monday through Friday.

H&SS Honors Program

Joseph Devine, Associate Dean for Undergraduate Studies
www.hss.cmu.edu/aac/honors

From its inception in 1982, the H&SS Honors Program has provided outstanding undergraduate students with the opportunity to work individually with faculty members throughout the College. The Honors Program is a senior-year program. Admission to the Program is based on achievement of a QPA of at least 3.50 in the major and 3.25 overall, departmental recommendation, and endorsement by a faculty sponsor. Honors Students enroll in an honors course for both the Fall and Spring semesters of the senior year. Upon successful completion of the honors thesis, an H&SS Honors student qualifies for graduation with H&SS "College Honors," and will have this designation as well as the thesis title noted on the final transcript.

Students have found the Honors Program to be a very positive experience in allowing for focused, individualized work on a sustained independent project. The annual growth in the number of student participants in the program, the diversity of the topics investigated and the breadth of interest across departments attest to the popularity and impact of the program. In the opportunity it provides to demonstrate one's abilities for achievement at this level, it comprises an experience that helps significantly in presenting oneself to prospective employers or graduate programs.

Humanities Scholars Program

Timothy Haggerty, Director
 Office: Baker Hall 154R
<http://www.hss.cmu.edu/hsp/>

The Humanities Scholars Program (HSP) is an undergraduate initiative to foster superior academic work within the College of Humanities and Social Sciences. Program officers work with admissions and advising to select a cohort of scholars who have a special interest or affinity in the humanities as they are conceptualized at the university. These scholars are invited into a program that includes a shared set of classes as well as a residential component during the first year.

As practiced within its four departments - English, history, philosophy and modern languages - the humanities at Carnegie Mellon provide broad reflexive analysis of humanity and its artifacts. Scholarship may incorporate, as examples, hermeneutic, ethnographic, critical, formal, or quantitative analyses within its arguments. At Carnegie Mellon, research has yielded themes that have become institutional strengths, including social and global perspectives on culture, science and technology; languages, literature and discourse; the arts in society; cognition and rational decision making; and ethics and public policy.

During the first two years of the program, scholars take a series of four seminars that are designed to introduce them to different humanities and disciplinary approaches (representative

HSP seminars can be viewed on the website). The program complements, rather than replaces, a major or minor course of study, and HSP courses help fulfill breadth requirements, including the freshman seminar requirement and selected General Education requirements within the college.

While in the program, scholars also participate in extracurricular events on campus and in the community that may include talks by visiting scholars, theater performances, conferences, and exhibits that highlight the importance of humanistic inquiry and its relevance in public discourse.

Students complete their research under the direction of a faculty advisor and meet in a research seminar headed by the director of the program in the spring of their fourth year. This seminar is designed to develop and showcase their abilities in addressing a topic from multiple interdisciplinary standpoints.

Science and Humanities Scholars Program

William Alba, Director
 Office: Doherty Hall 2201
<http://www.cmu.edu/shs/>

The Science and Humanities Scholars Program (SHS) is an innovative program that is designed to enable talented students to develop an undergraduate curricular program that builds upon their interests and achievements in the humanities, natural sciences, mathematics, or social sciences. The program is based on a special general education core that provides an academic base from which students can select a major in either the College of Humanities and Social Sciences or the Mellon College of Science.

Some features of the SHS program include:

- Equal access to courses in both MCS and H&SS
- An optional residential program that allows a group of SHS first-year students to live together in a dormitory cluster
- Opportunities to collaborate with faculty in cutting-edge interdisciplinary research
- A broad selection of freshman seminars led by distinguished faculty from across the two colleges

The College of Humanities and Social Sciences and the Mellon College of Science share a common commitment to providing students with professional experiences through independent studies or research with distinguished faculty members. Both share an interest in fostering the interdisciplinary, critical thinking and problem-solving skills that lead to success.

Study Abroad Scholarships

http://www.hss.cmu.edu/departments/deans_office/aac/scholarships_studyabroad.html

The Dean's Office for the College of Humanities and Social Sciences is pleased to offer the following scholarships to encourage study abroad.

The Brona Stein Buerger Scholarship

These annual scholarships will provide funds for up to one or two H&SS, BHA or SHS students, from any class or major, to be used toward a semester or full year of study in an accredited program of education abroad. Current sophomores and juniors will receive preference. This award has been given in memory of Brona Stein Buerger, Margaret Morrison class of 1962.

The Hannah Estermann Bergman Travel Fund

This annual scholarship will provide funds for up to one H&SS student who is currently studying Spanish. Preference will be given to sophomores and juniors who are Modern Languages majors. This award has been given in memory of Hannah Estermann Bergman, Margaret Morrison class of 1946.

Alumni Travel Scholarship

Multiple scholarships are awarded each year to H&SS, BHA, and SHS students to be used toward a semester or full year of study in an accredited program of study abroad. Current sophomores and juniors will receive preference. These funds are generously provided by H&SS Alumni.

H&SS Summer Internship Opportunity Grants

http://www.hss.cmu.edu/departments/deans_office/aac/scholarships_summer.html

H&SS encourages students to find and undertake interesting internship opportunities for their summer employment. We understand that many of these opportunities are unpaid, or, at best, provide minimal pay. Yet it is often these very positions that provide students with first-rate, challenging work experiences that are invaluable in helping them define and move forward to their career goals.

We have instituted the H&SS Summer Internship Opportunity Grants Program to make it more possible for students to take advantage of less remunerative, worthwhile internship opportunities. Grants of up to \$2,000 per internship are available.

Who is eligible? Undergraduates with primary majors in H&SS, BHA and SHS and strong academic records are encouraged to apply. Current sophomores and juniors will receive preference. NOTE: Graduating seniors are not eligible to compete.

How to locate internship opportunities? Students are expected to find their own internships. There are many available resources open to them through the Career Center and TartanTrak; in their own particular schools and departments; and through experiences to fellow students who have participated in internships during past summers. Preference is given to students who find positions in government or non-profit agencies.

Washington Semester Program

Connie Angermeier, Advisor
Office: Porter Hall 208

As part of its internship offerings, Carnegie Mellon is one of a number of universities throughout the nation which participate in "The Washington Semester Program," a cooperative arrangement with The American University in Washington, D.C. Students are selected by each of the participating colleges to spend a semester in the nation's capital. The program consists of study through a seminar; an elective course or an individual research project; and an internship at one of the hundreds of Washington-based organizations. Programs are available in the following areas: American Politics; Economic Policy; Foreign Policy; International Business and Trade; International Environment and Development; Journalism; Justice; Law Enforcement; Peace and Conflict Resolution; Public Law; and Transforming Communities. More information can be found on their website: www.american.edu/washingtonsemester/

Academic Standards and Regulations

Transferring into H&SS

All undergraduate students in other Carnegie Mellon colleges who wish to transfer into H&SS apply in the H&SS Academic Advisory Center, Baker Hall A57. Approved transfer will be into the college. Decisions regarding transfer requests will be based on evidence of adequate prior academic performance and on the applicant's prospects for success in the H&SS major requested.

Academic Actions

In order to maintain good academic standing, students in the College must reach or exceed minimum quality point averages (for each semester and cumulatively), and also maintain adequate progress toward completing graduation requirements. Quality point averages for good academic standing are 1.75 in the freshman year and 2.00 thereafter.

When a student fails to meet minimum performance criteria, an "academic action" normally results. Depending on the circumstances, one of three actions are taken: Probation, Suspension, or Drop. These academic actions are recommended by the College's departments based on the guidelines described below at the end of each semester and imposed by the College Council.

Probation

A student is placed on probation when the student's performance either for the semester or cumulatively fails to meet the minimum

standard. The term of "Academic Probation" is one semester, and signifies to the student the College's insistence that academic performance return to at least minimum acceptable level. A student is removed from probation, and returned to good academic standing, when both the semester and cumulative quality point averages meet or exceed stated minimums. A student who has had one semester on probation and is not yet meeting minimum requirements, but whose records indicates sufficient progress toward meeting minimum requirements, may be continued on academic probation.

Suspension

Academic Suspension is the usual action when a student fails to meet the minimum semester and cumulative requirements for two consecutive semesters. In general, a freshman will be suspended if the semester and overall QPA are below 1.75; for sophomores, juniors, and seniors, if these are below 2.00. Failure to maintain adequate progress toward graduation may also be a contributing factor in such decisions.

The minimum period of suspension is two semesters. At the end of that period, a student may seek readmission (on Final Academic Probation). In order to receive clearance to return, the student must do the following: formally request this clearance in writing, describing in detail the relevant activities pursued during the suspension period, provide transcripts from other colleges and universities if courses have been taken while on suspension because the College limits the number of courses that can be taken while on suspension for transfer credit, provide evidence of satisfactory on-the-job performance if the student has worked while on suspension, and furnish the names and addresses of three individuals with whom he or she has worked or studied, to whom the College will write with a request for a letter of reference on the student's behalf.

Once cleared to return from suspension by the College Dean's Office, the student must file an Application for Return from a Leave of Absence and obtain all necessary signatures. While on Suspension, students are considered to be on a "Leave of Absence" [albeit mandatory], and are governed by College and university policies concerning leaves of absence and withdrawals. See subsequent discussions of "Leave of Absence and Withdrawal from the College."

Drop

The most severe academic action occurs when the student is dropped from the College, and not permitted to be enrolled again. This normally results when a student, already on Final Academic Probation, continues to perform at levels less than the minimum set by the College for good academic standing, and shows no indication of being able to reach an acceptable level of performance or maintain steady progress toward completing graduation requirements.

The relation indicated above between probation, suspension and drop is not automatic in all cases. These "academic actions" are based on individual student performance and are not determined purely by formula. Thus, a student who achieves a 2.00 quality point average may be placed on probation for a very erratic performance; and in special circumstances, College Council may drop or suspend a student without prior probation.

H&SS Dean's Honor List

Each semester the College recognizes those students who have attained outstanding academic records by naming them to the College's Dean's List. H&SS students are eligible for the Dean's List who complete a minimum of 45 factorable units of work with a quality point average of at least 3.50 and with no conditional grades (I, X) at the time final grades are recorded.

Students who attain a minimum semester QPA of 3.50 through 3.74 are named to the Dean's List, with Honors; students who attain a minimum semester QPA of 3.75 or higher are named to the Dean's List, with High Honors.

Those who have completed 36 to 45 factorable units and attain a minimum semester QPA of 3.75 are named to the Dean's List with Honors.

Course Overloads

Overloading is defined as taking more than the equivalent of five full semester courses; it usually means registering for more than 50 units per semester. Eligibility for overloading is defined as having a QPA of 3.00 (or higher) in the last completed semester and a current cumulative QPA of 3.00 (or higher). Eligibility does

not automatically allow the student to register for more than 50 units; eligible students must be granted special permission through: completing a Petition to Carry an Overload for H&SS Students form and meeting with the student's primary academic advisor to discuss overloading. If approved, online processing of the unit increase is through the academic advisor.

All petitions approved before the posting of final grades for the semester preceding the overload semester are subject to revocation if the student does not achieve a 3.00 semester QPA (or higher). It is the student's responsibility to discuss this matter with their academic advisor.

Physical Education, StuCo and Military Science Courses

A maximum combination of nine units of credit for Physical Education, StuCo and all Military Science courses may be counted for credit toward graduation as free electives in any H&SS program. Physical Education, StuCo and Military Science courses are not included when calculating a student's QPA or when calculating units to determine eligibility to "overload."

Course Failures and Course Repetitions

Students who fail a required course must repeat and pass it (or take and successfully complete another approved course that fulfills the requirement). Exception: Freshman Seminar courses may not be repeated. If a failed course is a prerequisite to more advanced course work within a particular course sequence, the failed course must in general be repeated before moving on to the higher level course.

Failed courses that are repeated and passed, or courses that are passed by repeated in order to obtain a higher grade, are not replaced on the student's record; both course grades remain on the record, and are included in calculating the student's official QPA.

Internships-for-Credit

Policies and practices with respect to internships for credit vary among the College's departments. No department is obligated to provide or offer credit for an internship for its majors.

An internship for credit is a supervised professional work experience with clear links to a student's academic program performed primarily or totally outside a regular course and for which a student may be able to earn academic credit.

Each department in the College that allows its majors to earn academic credit for an internship has a statement that describes its internship policies and practices. Each department has a coordinator (or a committee) that approves, administers and monitors departmentally sponsored internships. Each department determines how (and if) an internship may be applied to its curriculum for fulfilling course requirements (i.e., whether as a required course, a course that fulfills a major requirement, or as an elective course).

Credits are earned according to the following scale: 9 units = the equivalent of 1 day (9-12 hours) per week during a semester (100 hours), 18 units = the equivalent of 2 days (12-20 hours) per week during a semester (200 hours)

A H&SS student may not earn more than 18 units of internship credit during a semester or count more than 27 units of internship credits toward fulfilling graduation requirements. An internship-for-credit is a graded experience. Each department, through its monitoring committee, will determine appropriate criteria for the grade in an internship. Students doing an internship for credit must be registered for the internship during the term (including the summer) when they are doing the work.

Some internship sponsors offer payment to an intern in addition to whatever academic credit the University offers.

The University's liability insurance for students does not cover a student while they are doing an off campus internship.

H&SS Credit Policy for Non-Carnegie Mellon Courses

The following policy governs the practice of H&SS undergraduates taking courses elsewhere and requesting that credits for these courses transfer to their Carnegie Mellon University student record. Courses taken elsewhere will be considered for transfer credit if they and the institution offering them are of a level and rigor comparable to Carnegie Mellon University.

Limits

Once a student enrolls in the university as a degree candidate, he or she may take a maximum of five courses (or their rough unit equivalent) elsewhere and transfer these back for credit toward their CMU degree. No courses may be transferred for these courses in the H&SS General Education Program:

- 76-101, Interpretation and Argument (or 76-100) from H&SS GenEd Category "Communicating"
- 79-104, Introduction to World History from H&SS GenEd Category "Reflecting"
- 36-201, Statistical Reasoning from H&SS GenEd Category "Deciding"
- FSR, Freshman Seminar
- C@CM, Computing @ Carnegie Mellon

In addition, no more than 2 courses from another institution may be counted for General Education; no more than 1 course from another institution may count in any one category (e.g., "Communicating," "Reflecting," etc.)

Exceptions

These limits do not apply to credits approved through Advanced Placement Examinations, International Baccalaureate Examinations, Cross-Registration through PCHE, Washington Semester program, Study-Aboard, or Exchange and Education-Abroad courses. Exceptions to these restrictions may be made only by way of written petition to the H&SS College Council (c/o the Academic Advisory Center).

Grades

Courses taken elsewhere must be taken for a grade of A, B or C (not Pass/Fail). A "C-" grade is not a transferable when its equivalency is below a 2.00 or 70%. Grades do not transfer and do not affect the Carnegie Mellon semester or cumulative QPA.

External Transfer Students

For students entering CMU/H&SS as external transfers, the same five course limit applies until and unless their transfer credits reach the 180 unit ceiling stipulated by college policy. The college has a residency requirement of a minimum of 180 CMU units. If a degree have been already obtained at another institution (outside of CMU), courses that were counted toward that degree may not be used again as transfer credit toward a CMU undergraduate degree.

Internal Transfer Students

This policy applies retroactively to students who enter H&SS through internal transfer and counts courses taken elsewhere and approved for transfer credit prior to internal transfer into H&SS.

Students on Suspension

Students on suspension from H&SS will be permitted to receive credit for no more than three courses per semester elsewhere, and no more than a total of five courses elsewhere, while on suspension. These limits may be lower if the student has already (prior to suspension) had credits transferred under the quota limits. Clearance to take these courses for credit should be approved in advance.

H&SS Department Limits

H&SS academic departments do not exceed these college limits, but may impose stricter limits regarding courses students propose to take elsewhere to fulfill major requirements.

Double-Counting Courses

"Double-counting" refers to instances when a course taken to fulfill one requirement counts simultaneously toward a requirement in another major or minor program. While the College encourages study in complementary areas where majors and minors frequently share common requirements, it also wants to keep clear the meaning and integrity of the labels "major" and "minor." To preserve the integrity of these definitions, the College permits double-counting requirements on a very limited basis, and only in those instances when the course(s) in question represent only a small portion of the second program.

The College and its departments have developed program-specific guidelines for this practice that appear throughout the H&SS section of this catalog, and particularly in the case of major and minor programs that students frequently pursue in combination.

The College requires that an additional major be based on at least six independent courses, excluding prerequisites, and a minor based on at least five independent courses ("independent courses" are courses not counted toward any other program requirement).

Graduation Requirements

Eligibility for graduation in H&SS requires that a student:

- 1) complete all General Education (GenEd) requirements,
- 2) complete all course requirements in the primary major,
- 3) achieve a cumulative quality point average of at least 2.00 for all courses taken after the 1st year,
- 4) complete 360 units with a minimum of 180 units taken at Carnegie Mellon University,
- 5) be recommended (certified) by the faculty of the College,
- 6) meet all financial obligations to the University, and
- 7) qualify for graduation no more than eight years from the date units completed toward the undergraduate degree were earned.

The College reserves the right to modify these academic standards, actions, and regulations.

Graduation with University Honors

H&SS students who achieve an overall QPA of at least 3.50 (by the end of the 7th semester) will be recommended for graduation "With University Honors."

Graduation with College Honors

Students who successfully complete a senior honors thesis under the auspices of the H&SS Senior Honors Program (application required) qualify for graduation with "H&SS College Honors."

Student-Defined Program

Joseph E. Devine, Associate Dean
Office: Baker Hall A57, H&SS Academic Advisory Center

For H&SS students whose educational goals cannot be as adequately served by the curricula of existing majors, the College provides the opportunity to self-define a major or minor. The procedure for establishing such a major centers on a written proposal, submitted to the College's Dean's Office (c/o the H&SS Academic Advisory Center). This proposal, which is to be built on the College's General Education Program, consists of two parts:

Major Description and Rationale: A description of the components of the proposed program of study; a presentation of the objectives of the program of study, why it represents a coherent and (given available faculty, courses, and other resources) viable course of study, and the reason(s) why these objectives cannot be accomplished within one or more of the College's existing majors.

The Curriculum: Presentation of a complete outline of all courses that will comprise the requirements for the major, categorized according to that component of the major program to which each belongs (e.g., mathematics prerequisites; research methods; theoretical perspectives; etc.), and second, a semester-by-semester outline that indicates when each course is to be taken (or, for any already taken, when taken and grade received). The minimum requirement for graduation is, as with all majors in the College, 360 units of credit.

Proposals and curricula are evaluated for clarity of focus, coherence and depth in related areas, and viability within the context of the College and university. Proposals should generally be developed no later than the sophomore year, and approved majors begin their program generally no later than the junior year.

H&SS Interdepartmental Majors

When addressing complex issues in society, pursuing research in industry, in government, or at the university, and in many other contexts, we often rely on approaches that take advantage of a variety of relevant disciplines. The College houses the special category of "Interdepartmental Majors" for programs where this interdisciplinary spirit is most pronounced and in which the varied disciplinary perspectives are more fully integrated. These majors are presented separately, rather than as departmentally-based options, to reflect and underscore their sponsorship by more than one H&SS department, and the unique flavor that follows from this structure.

Interdepartmental majors are administered by the academic department of the major's faculty advisor.

The Major in Economics and Statistics

Faculty Advisor: Oded Meyer

Office: Baker Hall 232C

The major in Economics and Statistics provides an interdisciplinary course of study aimed at students with a strong interest in the empirical analysis of economic data. Jointly administered by the Department of Statistics and the Undergraduate Economics Program, the major's curriculum provides students with a solid foundation in the theories and methods of both fields. Students in this major are trained to advance the understanding of economic issues through the analysis, synthesis and reporting of data using the advanced empirical research methods of statistics and econometrics. Graduates are well positioned for admission to competitive graduate programs, including those in statistics, economics and management, as well as for employment in positions requiring strong analytic and conceptual skills – especially those in economics, finance, education, and public policy.

Curriculum

I. Prerequisites 74 Units

1. Writing Prerequisite 9 units

Choose one:

- 73-270 Professional Writing for Economics
- 76-270 Writing in the Professions
- 76-271 Intro to Professional and Technical Writing

2. Mathematical Foundations 38 units

- 21-120 Differential and Integral Calculus
- 21-122 Integration, Diff Equations, and Approximations
- 21-256 Multivariate Analysis and Approximation
- 21-241 Matrix Algebra

3. Economics Foundations 9 units

- 73-100 Principles of Economics

3. Statistical Foundations 18 units

- 36-201 Introduction to Statistical Reasoning and Practice*

and one of the following:

- 36-202 Introduction to Statistical Methods
- 36-208 Regression Analysis (cross listed as 70-208)
- 36-309 Experimental Design for Behavioral & Social Sciences

* Acceptable equivalents for 36-201 are 36-207, 36-220, and 36-247.

II. Disciplinary Core 111 units

1. Economics Core 39 units

- 73-150 Microeconomics
- 73-200 Macroeconomics
- 73-252* Advanced Microeconomic Theory
- 73-253* Advanced Macroeconomic Theory
- 73-261 Econometrics

* Mini courses

2. Statistics Core 36 units

- 36-225 Introduction to Probability and Statistics I
- 36-226 Introduction to Probability and Statistics II
- 36-401 Modern Regression
- 36-402 Advanced Data Analysis (Project Course)

3. Economics Electives 18 units

Choose two advanced courses (numbered 73-100 through 73-495)

4. Statistics Electives 18 units

Choose two courses at the 36-300 level or above.

Total number of units for the *major* 185 units

Total number of units for the *degree* 360 units

Sample Program

The following sample program illustrates one (of many) ways to satisfy the requirements of the Economics and Statistics Major. Keep in mind that the program is flexible and can support other possible schedules (see comment following the schedule).

Year	Fall	Spring
Freshman	21-120 36-201 -----** ----- -----	21-122 36-202 73-150 ----- -----
Sophomore	21-256 36-225 73-200 ----- -----	21-241 36-226 73-252/3 ----- -----
Junior*	36-401 73-261 Writing Req. Econ Elective -----	36-402 Stats Elective ----- ----- -----
Senior	Stats Elective ----- ----- ----- -----	Econ Elective ----- ----- ----- -----

* A student could spend, for example, year 3 abroad and move year 3 courses to year 4.

** In each semester, ----- represents other courses (not related to the major) which are needed in order to complete the 360 units that the degree requires.

Additional Major in Environmental Policy

Peter Madsen, Faculty Director
Office: Baker Hall 161F

The additional major (only) in Environmental Policy focuses attention on the interaction of humans with the environment from a multitude of perspectives. Human activities have had and continue to have large-scale and long-term consequences for environmental quality. Environmental quality relates to the quality of our daily lives, to our physical health, and to the future vitality and even survival of human society. The Additional Major in Environmental Policy is designed to provide students with the interdisciplinary background and skills necessary to understand environmental issues. It emphasizes three general areas: (1) humanities and the arts; (2) social sciences; and (3) natural science and technology. The humanities emphasis concerns the ethical, legal, and historical basis of environmental concerns as well as their aesthetic manifestations. The social science area concentrates on the economic and political nature of environmental problems and possible policy options and responses. The natural science and technology focus includes the exploration of ecology as well as the role of technology as both problem creator and problem solver.

The Environmental Policy major is open to all students as an additional major. It is administered by an interdepartmental committee, with Peter Madsen, of the Philosophy Department, as principal advisor. The major features training in relevant research methods; a set of core courses on environmental issues from several disciplinary vantage points; an elective; and a project course experience.

Prerequisites 47-56 units

Two courses in calculus (e.g., 21-111/112 or 21-121/256)
Two courses in statistics (e.g., 36-201 or the equivalent)
Two courses in biology (e.g., 03-121 and 122, 124 or 130)
or
Two courses in chemistry (e.g., 09-103/104 or 09-105/106)
or
Chemistry 09-103 and 06-100 Introduction to Chemical Engineering

The following courses are recommended, although not required, to complete: 73-100, Principles of Economics or 73/88-110, Experiments with Economic Principles

Research and Analytical Methods 18 units

79-200 Historical Evidence and Interpretation
or
85-340 Research Methods in Social Psychology
73-251 Economic Theory

Theory and Context 54-57 units

Required 45-48 units

66-210 Science and Technology for the Environment
or
79-346 International Environmental Law and Policy
or
90-792 Environmental Decision Making
80-344 Management, Environment and Ethics

Required Electives 9-12 units

Complete one course in one of the following areas:

Science and Technology

12-100 Introduction to Civil and Environmental Engineering*
12-251/252 Introduction to Environmental Engineering
(if not taken in the required category)
12-651 Air Quality Engineering*
12-651 Environmental Engineering: Air Pollution*
19-101 Introduction to Engineering and Public Policy*
19-321 Law and Technology
19-422 Radiation, Health, and Policy
19-448 Science, Technology, and Ethics
19-622 Sustainability (6 units)
19-623 Environmental Management (6 units)
24-424 Energy-Environmental Systems (also listed as 19-424)
42-424 Biological Transport

* particularly extensive prerequisites; not to be taken by students whose primary major is in CIT

Humanities

76-319 Environmental Rhetoric
76-395 Science Writing
76-476 The Rhetoric of Science
79-384 Medicine and Society
80-244 Management, Environment and Ethics

Social Sciences

19-446 Quantitative Risk Analysis
73-251 Economic Theory
73-358 Economics of the Environment and Natural Resources
85-241 Social Psychology
88-220 Policy Analysis I (if not taken in the required category)
88-221 Policy Analysis II
88-223 Decision Analysis and Decision Support Systems
88-302 Behavioral Decision Theory
88-425 Politics of Economic Deregulation
90-765 Cities, Technology and the Environment
90-767 Climate Change, Energy Policy and Sustainable Development
90-773 Technology, Environment and Economic Development
90-789 Sustainable Community Development
90-798 Environmental Policy & Planning

Evaluation and Design 12 units

19-451 Engineering and Public Policy Projects (pre-approved sections);

or

88-222 Policy Analysis III (pre-approved sections);

or

79-410 History and Policy Project (pre-approved sections)

The Major in Ethics, History, and Public Policy

Undergraduate Advisor: Andy Norman, Department of Philosophy

Office: Baker Hall 161F

Preparing students for leadership positions is a vital goal of colleges and universities in every democratic and technologically advanced society. The intellectual challenges facing public and private sector leaders expand dramatically each year, and there will be a compelling need in 21st century America for broadly educated, ethically sensitive, and technically skilled public servants. They will have to demonstrate sophisticated interdisciplinary knowledge, historical understanding of how modern-day problems have evolved, and an operational grasp of clear, rational criteria for ethical decision making. The major in Ethics, History, and Public Policy seeks to provide students with a solid humanistic and social-scientific foundation for developing such high-level leadership capabilities. It also provides ample room for specialization, technical skill development, and internship experience in a wide range of policy areas.

Curriculum

Offered jointly by the Departments of History and Philosophy, the Ethics, History, and Public Policy major is offered for either a B.A. or a B.S. degree, or as an Additional Major (see below). The requirements for either degree or for an additional major include a minimum of 117 units (thirteen 9-unit courses) divided into History and Philosophy Core Courses (72 units) and Elective Track courses (45 units). An Internship Option may be taken Pass/Fail for 9 units of academic credit by students who qualify (with a 3.0 overall QPA, a 3.25 QPA in their EHPP major, and with pre-approval by the Internship Coordinator). Students interested in an internship for academic credit should consult the policy and information at <http://www.hss.cmu.edu/departments/history/under/internships.html>. No Pass/Fail course (e.g. 79-505) may count toward any major requirement. Only one course for an EHPP major may double count toward another major or minor. Two courses for an EHPP major may double count towards the 2004 H&SS General Education requirements.

Bachelor of Science Option 18 units

Complete two of the following courses. None may double count for an H&SS General Education requirement.

- 21-257 Models & Methods for Optimization
(Prerequisite 21-256)
- 36-303 Samplings, Surveys, & Society
(Prerequisites include 36-201)
- 36-207 Probability & Statistics for Business
(Prerequisites: 21-116 or 21-121)
- 36-208 Regression Analysis
(Prerequisites: 36-207 or 21-116 or 21-121)
- 80-222 Measurement & Methodology (Prerequisite: 21-228)
- 80-305 Rational Choice
(Prerequisites: 36-226 or 36-202 or 36-217)
- 80-316 Causation, Probability & Artificial Intelligence
(Prerequisites: none)
- Or:
Any Gen Ed 3. Modelling: Mathematics & Experiments course option not used to fulfill that requirement.

Internship Option 9 units

79-505 Undergraduate Internship Pass/Fail Only

For an internship to receive academic credit it must be pre-approved by the History Department Internship Coordinator. Consult the policy and information on internships at <http://www.hss.cmu.edu/departments/history/under/internships.html>.

History Core Courses 36 units

1) Complete one of the following courses in American history.

- 79-204 20th Century America
- 79-206 Development of American Culture
- 79-240 Recent United States History, 1945-Present
- 2) Complete one of the following courses in policy history/social history.
- 79-202 The History of Public Policy in the United States
- 79-230 Technology in American Society
- 79-242 African American History II
- 79-256 Biology and Society
- 79-309 Public Policy and American Military Recruitment: Historical Perspective
- 79-331 Crime and Punishment in American Society
- 79-332 Juvenile Delinquency: Images, Realities and Public Policy, 1800-1940
- 79-333 History of Biomedical Research
- 79-335 Drug Use & Drug Policy
- 79-336 Epidemic Disease & Public Health
- 79-338 Childhood, Education, & Social Reform in American History
- 79-345 American Environmental History
- 79-384 Medicine & Society

3) Complete one of the following courses in international history

- 79-205 20th Century Europe
- 69-207 Development of European Culture
- 79-233 The United States & the Middle East Since 1945
- 79-253 Development of Caribbean Culture
- 79-258 Intro to African History: 18th Century to Neocolonialism
- 79-271 Modern China
- 79-281 Russian History: From Communism to Capitalism
- 79-288 Bananas, Baseball, and Borders: A History of Latin America - US Relations
- 79-289 Development and Democracy in Latin America
- 79-290 Between Revolutions: The Development of Modern Latin America
- 79-397 Religion & Politics in the Middle East

4) Complete one other course from the options under (2) or (3).

Philosophy Core Courses 36 units

1) Complete one of the following ethics courses.

- 80-130 Introduction to Ethics
- 80-230 Ethical Theory

2) Complete one of the following courses in political philosophy

- 80-135 Introduction to Political Philosophy
- 80-235 Political Philosophy

3) Complete one of the following courses in applied philosophy/applied ethics.

- 80-136 Social Structure, Public Policy, & Ethics
- 80-221 Philosophy of Social Science
- 80-236 Philosophy of Law
- 80-242 Conflict & Dispute Resolution
- 80-348 Health, Development, & Human Rights
- 80-321 Causation, Law, and Social Policy
- 80-430 Ethics & Medical Research

4) Complete one other course from any of the options above.

Elective Tracks 45 units

Complete 45 units (five 9-unit courses) from one of the two Elective Tracks below: Social Policies; or, Business & Economic Policies. New or other courses similar to those below might be offered that may be counted with the permission of your advisor.

Social Policies Track

- 19-319 Law & the Engineer [See EPP catalog for prerequisites]
- 19-321 Law & Technology [See EPP catalog for prerequisites]
- 19-422 Radiation, Health, & Policy [See EPP catalog for prerequisites]
- 19-424 Energy & the Environment [See EPP catalog for prerequisites]
- 19-426 Environmental Decision Making [See EPP catalog for prerequisites]
- 19-448 Science, Technology, & Ethics [See EPP catalog for prerequisites]
- 70-361 Foundations of Law
- 70-363 Law in Modern American Society
- 70-413 Conflict Resolution: Negotiation & Mediation
- 73-354 Law & Economics
- 73-356 Political Economy of Public Institutions
- 73-357 Regulation: Theory & Policy
- 73-358 Economics of the Environment & Natural Resources
- 73-359 Benefit-Cost Analysis
- 73-476 American Economic History
- 79-230 Technology in American Society
- 79-242 African American History II
- 79-243 A History of American Urban Life
- 79-244 Pittsburgh and the Transformation of Modern Urban America
- 79-256 Biology & Society
- 79-281 Modern Soviet History: From Communism to Capitalism
- 79-288 Bananas, Baseball, and Borders: A History of Latin America - US Relations
- 79-309 Public Policy and American Military Recruitment: Historical Perspective
- 79-330 The American Presidency
- 79-331 Crime & Punishment in American Society
- 79-332 Juvenile Delinquency: Images, Realities and Public Policy, 1800-1940
- 79-333 History of Biomedical Research
- 79-335 Drug Use & Drug Policy
- 79-345 American Environmental History: Critical Issues
- 79-368 Poverty, Charity, and Welfare
- 79-384 Medicine & Society
- 80-221 Philosophy of Social Science
- 80-235 Political Philosophy
- 80-336 Philosophy of Law
- 80-244 Management, Environment, & Ethics
- 80-245 Medical Ethics
- 80-348 Health, Development, & Human Rights
- 80-321 Causation, Law, & Social Policy
- 80-341 Computers, Society, & Ethics
- 80-430 Ethics & Medical Research
- 88-104 Decision Processes in American Political Institutions
- 88-309 Altruism & Selfishness
- 88-313 Rationality & Values in Democracy
- 88-322 Elections, Interest Groups, & Public Policy
- 88-340 Law & Public Policy

Business & Economic Policies Track

19-319	Law & the Engineer [See EPP catalog for prerequisites]
19-424	Energy & the Environment [See EPP catalog for prerequisites]
19-426	Environmental Decision Making [See EPP catalog for prerequisites]
70-311	Organizational Behavior
70-332	Business & Society
70-413	Conflict Resolution: Negotiation & Mediation
70-430	International Management
73-330	Comparative Economic Systems
73-354	Law & Economics
73-351	Public Finance
73-356	Political Economy of Public Institutions
73-357	Regulation: Theory & Policy
73-359	Benefit-Cost Analysis
73-365	Industrial Organization
73-371	International Trade
73-372	International Money & Finance
73-380	Strategy in Economics and Politics
73-476	American Economic History
79-230	Technology in American Society
79-345	American Environmental History: Critical Issues
79-358	Complex Technological Systems: Past, Present, and Future
79-440	Perspectives on Industrial Research and Development
80-221	Philosophy of Social Science
80-321	Causation, Law, & Social Policy
80-242	Conflict & Dispute Resolution
80-243	Business Ethics
80-244	Management, Environment, & Ethics
88-104	Decision Processes in American Political Institutions
88-223	Decision Analysis & Decision Support Systems
88-309	Altruism & Selfishness
88-313	Rationality & Values in Democracy
88-343	Economics of Technological Change
88-425	Politics of Economic Deregulation

Sample Elective Track Concentrations

Students may, if they wish, concentrate their Elective Track courses in a topical area of special interest to them. The following four sample concentrations are illustrated with course options under the Social Policies Elective Track. The Business & Economic Policies Elective Track similarly accommodates special-interest concentrations, for example concentrations emphasizing international business and economic policies, or environmental policy. Students specially interested in International Relations are well advised to pursue the International Relations additional major or minor along with the EHPP major and to choose an EHPP Elective Track and concentration consonant with their International Relations interests. Only one course taken for the EHPP major may be double counted for any additional major or minor.

Medicine & Health Policy

19-422	Radiation, Health, & Policy [See EPP catalog for prerequisites]
79-256	Biology & Society
79-333	History of Biomedical Research
79-335	Drug Use & Drug Policy
79-384	Medicine & Society
79-256	Biology & Society
80-245	Medical Ethics
80-348	Health, Development & Human Rights
80-430	Ethics and Medical Research
85-442	Health Psychology
90-650	Intro to Health Care Management

Law & Social Policy

73-354	Law & Economics
70-361	Foundations of Law
70-363	Law in Modern American Society
79-309	Public Policy and American Military Recruitment: Historical Perspective
79-331	Crime & Punishment in American Society
79-332	Juvenile Delinquency: Images, Realities and Public Policy, 1800-1940
79-338	Childhood, Education, & Social Reform in American History
80-336	Philosophy of Law
80-321	Causation, Law, and Social Policy

80-348 Health, Development, & Human Rights

Environmental Policy

19-426	Environmental Decision Making [See EPP catalog for prerequisites]
73-358	Economics of the Environment & Natural Resources
79-345	American Environmental History
80-244	Management, Environment, & Ethics

Criminal Justice Policy

79-331	Crime & Punishment in American Society
79-332	Juvenile Delinquency: Images, Realities and Public Policy, 1800-1940
79-335	Drug Use & Drug Policy
80-336	Philosophy of Law

Ethics, History, and Public Policy
Sample Curriculum

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Core requirement in History or Philosophy	Core requirement in History or Philosophy	Elective Track Course	Elective Track Course
Core requirement in History or Philosophy	Core requirement in History or Philosophy	Elective Track Course	Elective Track Course
Core requirement in History or Philosophy	Core requirement in History or Philosophy	Elective Track Course	Elective
Core requirement in History or Philosophy	Core requirement in History or Philosophy	Elective	Elective

The above sample program is presented as a two-year (junior-senior year) plan for completing EHPP major requirements. Its purpose is to show that this program can be completed in as few as two years; not that it must be. Students may enter their EHPP major, and begin major course requirements, as early as the start of the sophomore year, or even in the first year. Students should consult their advisor when planning their program.

Additional Major

All Ethics, History, and Public Policy requirements for an additional major are the same as those for non-B.S. degree candidates whose primary major is EHPP. Only one course may double count for both a student's EHPP additional major and the student's primary major.

The Major in European Studies

Beryl Schlossman, Professor of French; European Studies Advisor

Offered jointly by Modern Languages and History, the Major in European Studies is a unique interdisciplinary program that seeks to develop and enhance students' understanding of European societies and cultures. It aims to train students in literature and language, cultural history and the arts, as well as related areas of professional opportunity. It offers students substantive knowledge of Western European society through two approaches. First, it provides a foundation in one of the continental Western European languages. Second, it encourages comparative inquiry across boundaries of time, nation, and scholarly discipline.

Curriculum

Offered jointly by the Departments of Modern Languages and History, the European Studies major is offered as a B.A. degree.

European Studies majors must take two prerequisite courses (18 units) in one foreign language (French, Spanish, or German) or demonstrate the equivalent in language ability through the Carnegie Mellon Language Placement Test. The requirements include a minimum of 99 units divided into core courses (63 units) and electives (36 units). Students are strongly advised to fulfill prerequisite and core courses by the end of their junior year. Students are encouraged to take advantage of the Study Abroad Program.

Students are urged to check with the Major Advisor in selecting courses for this major.

The Major in European Studies 99 units

Students who arrive at Carnegie Mellon with previous language study and/or who have high AP or CEEB scores will be able to begin taking courses toward the major earlier in their undergraduate program and will also be able, should they so desire, to complete an additional major. Progress toward the major will be accelerated by study abroad.

1. Core Courses in Modern Languages 36 units

Language courses are to be completed in the same language: French, German, or Spanish.

Complete two courses in a 200-level language sequence* 18 units

82-2xx 200-level language course
82-2xx 200-level language course

*Students who place out of 200-level language courses must take at least two 300-level courses instead of the required one 300-level language course.

Complete one course in a 300-level language course 9 units
82-3xx 300-level language course

Complete one course in a 400-level language course 9 units
82-4xx 400-level language course

2. Core Courses in History 27 units

Required Course 9 units
79-207 Development of European Culture

Pre-20th Century European History 9 units

Complete one 200-level (or above) course in Pre-20th century European history.
79-2xx/3xx Pre-20th century European History course

European History 9 units

Complete one 300-level course in European history.
79-3xx European History course

3. Electives 36 units

This list includes samples of courses that can be taken as appropriate electives in European history, literature, and culture in relevant departments. In any given semester, offerings differ. Students are urged to consult with the Major Advisor and with relevant departments for current offerings. Electives also may include additional 400-level courses in the target language, additional courses in Modern Languages, 200- and 300-level courses

in History, and some offerings in English and CFA.

History

79-250 Two Revolutions: Dynamics of Change in Nineteenth Century Europe
79-261 Europe after the Black Death
79-263 Riots, Revolts, and Revolutions
79-307 The Anthropology of Europe

Modern Languages

French:
82-406 The European Union
82-415/416 Topics in French and Francophone Studies

German:
82-424 The New Germany
82-427 Nazi and Resistance Culture

Spanish:
82-441 Studies in Peninsular Literature and Culture Art
60-350 Michelangelo and Renaissance Art
60-377 Picasso and the 20th Century

English
76-236 19th Century British Literature and Culture
76-331 Renaissance Literary and Cultural Studies
76-336 Romantic Age Literary and Cultural Studies

New courses will be added as appropriate.

European Studies (B.A.)

Sample Curriculum

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
300-level Language Course 82-3xx	400-level Language Course 82-4xx	European Studies Elective	European Studies Elective
Development of European Culture 79-207	Pre-20th Century European Course 79-2xx/3xx	European Studies Elective	European Studies Elective
Elective	European History Course 79-3xx	Elective	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed within two years. Students may enter their major, and begin major course requirements, as early as the start at the beginning of the sophomore year, and in some instances in the first year. Students should consult their advisor when planning their program.

This plan is an example of the suggested sequence of study for students who have had little or no prior exposure to the language. These students would need to satisfy the prerequisites (elementary and intermediate language study) during their freshman and sophomore years.

The Major in Information Systems

Faculty Program Director: Randy S. Weinberg
 Office: Porter Hall 224C, rweinberg@cmu.edu
 Program Advisor: Stephen Pajewski
 Office: Porter Hall 222F, sp4g@andrew.cmu.edu
 Faculty: C.F. Larry Heimann, Jeria Quesenberry, Raja Sooriamurthi

Information Systems (IS) is a unique and innovative undergraduate interdisciplinary program, drawing on a wide range of exciting college and university strengths. IS is an internationally recognized undergraduate major for students who want to design and implement effective solutions to meet organizational and management needs for information and decision support. IS majors study the organizational, technological, economic and societal aspects of computer-based information systems, and learn how these elements work together to affect real outcomes. Students completing the program will be well grounded in the fundamentals of organization theory, decision-making, teamwork and leadership, understanding and organizing complex problems, and research methods as well as develop in depth knowledge of current and emerging information systems methodologies and technologies. Graduates of the Program are ideally situated to take a leading role in managing and shaping our information-based future.

IS appeals to outstanding students with a wide range of backgrounds and interests. The major provides students with a broad liberal education (being situated in the College of Humanities & Social Sciences) along with training in the essential aspects of the design and implementation of information systems. The flexible nature of the program encourages students to explore their own interests in a contemporary content area. While all IS majors will become proficient in information technologies, they share a common interest in the effective application of these technologies to real organizational, managerial and societal needs for better information management and decision making.

IS students are well prepared to pursue graduate work in information systems, business administration, technology management and policy, human-computer interaction, and other related areas. Because of the broad training received within the IS fields and H&SS curricula, IS students are also positioned to pursue graduate degrees in some disciplinary fields of the social and behavioral sciences or in the humanities, as well. For students interested in master's degree-level graduate work at Carnegie Mellon, there are various possibilities, including accelerated Masters of Information Systems Management (MISM) and Masters of Business Administration (MBA) programs. Some of the undergraduate coursework for the IS major can be counted towards graduate requirements and the degree can usually be completed in three or four additional semesters.

IS students meet an important need in the information-age workplace. There has been a strong job market for IS students in recent years, and national trends indicate that this is likely to continue. IS majors often take jobs in consulting companies, major software firms, large corporations, and start-up companies. Internship opportunities closely parallel the job market.

In addition to the H&SS General Education Requirements and basic prerequisites in mathematics, statistics and computer programming, IS students must complete a Professional Core, the Disciplinary Core and a focused Content Area. In the Professional Core (consisting of five courses), students learn the basic skills necessary to analyze, design, implement and test information systems using current and emerging organizational and technological practices. Two of the Professional Core courses are project-based experiences in which small teams of students must develop and communicate solutions to real information problems.

In the Disciplinary Core (consisting of four courses), students study four areas that are fundamental to understanding and solving problems in information systems: organizations, decision sciences, research methods and professional communications. The organizations area emphasizes how groups of people can organize and coordinate their behaviors to perform complex tasks. The decision sciences area focuses on the necessary skills for understanding, structuring and computerizing decision-making at individual and organizational levels. The research methods area illuminates the process of gathering, summarizing, evaluating and presenting empirical data. The professional communications area develops skills in the most effective methods for presenting information.

IS students must also complete three courses within one Content Area. The Areas are designed to complement the depth provided by the Professional Core and the breadth provided by the Disciplinary

Core by providing an opportunity to gain additional depth in a focused area. Currently, eight Content Areas are available: (1) Organizations, (2) Decision Science and Rational Choice, (3) Research Methods, (4) Professional Communications, (5) Business/Economics, (6) Computers and Cognition, (7) Technology, and (8) Global Systems.

Transfer to Information Systems

Only IS students are allowed to enroll in the Professional Core courses, and IS students have enrollment priority in all IS electives. The target class size of these courses is determined annually by the College. If the target size is not met by existing IS students, then additional students may be admitted to the IS major as transfer students and are required to begin the Professional Core courses during the next available semester. (IS students are currently admitted directly into IS as incoming freshmen). Students who are accepted as transfers to the IS program can complete the requirements of the degree in two years with careful scheduling. Applications for admission to the major will be considered at the end of each semester. Students interested in applying for admission to the IS major should keep in touch with the IS advisor for information regarding availability, application procedures and deadlines. Potential applicants to the IS major should be working toward a sensible alternative major, so that their success at Carnegie Mellon is not predicated on admission to the IS program.

Study Abroad Options in Information Systems

Given the rise of globalization and its effect on information systems development, we encourage students to consider expanding their international experience by spending a semester studying abroad. The IS program is very flexible in allowing students to pursue these opportunities, and we have a number of strategic alliances with overseas universities to make it easy for students to find courses that will count towards major requirements. Most students who study abroad do so in their sophomore or senior years, although study abroad is possible in the spring of the junior year as well. The only semester study abroad is difficult is the fall of junior year due to the professional core requirements of 67-271 and 67-272. Students interested in study abroad should talk with the IS student advisor to help plan an appropriate course of study.

Additional Major and Minor

Information Systems is not available as either an additional major or minor.

Curriculum

The Information Systems major is offered only as a Bachelor of Science (B.S.) degree. In addition to major requirements outlined below, all Information Systems students must fulfill all H&SS General Education requirements.

Disclaimer: Requirements are subject to revision. Advisor approval is required for each student's major curriculum plan. No course used to fulfill the requirements of the major can be used to fulfill the requirements for any other major or minor nor used more than once to meet the requirements of this major without prior approval from the Information Systems Program.

Prerequisites

The prerequisites common to all Information Systems majors are presented below. All prerequisites must be successfully completed prior to the start of fall semester, junior year.

Mathematics 20 units

Complete any of the following three calculus sequences:

21-111	Calculus I	
and		
21-112	Calculus II,	
or		
21-120	Differential and Integral Calculus	
and		
21-256	Multivariate Analysis and Approximation,	
or		
21-120	Differential and Integral Calculus	
and		
21-122	Integration, Differential Equations, and Approximation	

Computer Programming 10-19 units

Units needed to fulfill this requirement category vary based on placement into the appropriate initial programming course from the programming placement test results.

- 15-100 Introductory/Intermediate Programming (10 units)
and
15-200 Advanced Programming/Practicum (9 units)
or
15-111 Intermediate/Advanced Programming (10 units)

Professional Core 51 units

Complete all five courses.

- 67-250 The Information Systems' Milieux
(or 67-344, Organizational Intelligence in the
Information Age, used as a substitution for IS transfer
students)
67-272 Application Design and Development
(prerequisites: 67-250 or 67-344 and 15-200 or 15-111)
67-371 Fundamentals of Systems Development
(prerequisites: 67-250 or 67-344 and 15-200 or 15-111)
67-373 Software Development Project
(prerequisites: 67-271 and 67-272);
67-475 Information Systems Applications
(prerequisite: 67-373)

Disciplinary Core 36 units

Complete one course from each of the four Disciplinary Core categories.

1. Organizations

The focus of this area is on how organizations, ranging from small groups of individuals to society at large, can be transformed by information technology. Students will develop a greater understanding of how to create effective information systems to meet key organizational needs, and how social policy can influence this outcome. Such knowledge can be readily applied by students pursuing careers in both the private and public sectors.

Complete one course:

- 67-344 Organizational Intelligence in the Information Age
70-311 Organization Behavior
70-341 Organizational Communication
70-342 Managing Across Cultures
70-414 Technology-Based Entrepreneurship
88-260 Organizations
88-341 Organizational Communication

2. Decision Science and Rational Choice

This area focuses on the decision making component of information systems, taking into account the social, political, and ethical issues in an information-driven society. This area builds on the analytic rigor of the social sciences and the enduring normative questions of philosophy to promote a critical understanding of the way that information technologies shape the contemporary world.

Complete one course:

- 73-251 Economic Theory
80-211 Arguments and Inquiry
80-305 Rational Choice
80-341 Computers, Society and Ethics
88-220 Policy Analysis I
88-223 Decision Analysis and Decision Support Systems

3. Research Methods

Understanding how data and information are acquired is an important first step to solving information problems. Moreover, discerning the patterns and trends in data can help guide an organization's information strategy. Research methods provide a basis for students seeking to understand these fundamental issues.

Complete one course. (It is recommended that this requirement be completed by the end of the sophomore year.)

- 36/70-208 Regression Analysis
36-202 Statistical Methods
36-303 Sampling, Survey and Society
36-309 Experimental Design for Behavioral and Social Sciences
80-222 Measurement and Methodology
88-251 Empirical Research Methods

4. Professional Communications

These courses help information systems designers understand how the structure and presentation of information affects how well (and how easily) it can be understood and used. In addition, information systems professionals are often called to facilitate communications between software engineers and non-technical business clients; consequently, the most successful information systems professionals are typically those with strong communication skills.

Complete one course. (It is recommended that this requirement be completed by the junior year.)

- 36-315 Statistical Graphics and Visualization
70-340 Business Communications
70-343 Interpersonal Communication
70-345 Oral Communications
70-346 Written Communications
76-270 Writing in the Professions

Content Area 27 units

Complete 27 units from a combination of IS Electives and one Content Area with a maximum of 9 units of IS Electives counting toward this requirement. With 9 units of IS electives, a minimum of 18 units from a Content Area are necessary, or with 6 units of IS electives, at least 21 units from a Content Area are needed. If none of the IS Electives are selected, all 27 units are to be from one of the eight Content Areas. Some courses in these Content Areas are the same as courses in the Disciplinary Core. A single course can only be used once to fulfill a Disciplinary Core or Content Area requirement.

A note on scheduling and availability: the courses listed for the Content Areas below are generally offered with some regularity. However, some courses may not be offered every year or enrollment priority may be given to declared majors or minors. Also, infrequently offered courses that would qualify for a Content Area may be available in a specific semester. Many of the courses in the Content Areas also have prerequisites. In most cases the prerequisites are also listed in the same Content Area, are part of the Disciplinary or Professional Cores, are acceptable to fulfill General Education requirements, or may be taken as part of a minor or second major. Students are advised to confer with the Information Systems program advisor and maintain some flexibility in selecting courses from their Content Area.

Information Systems Electives

A maximum of 9 units (of the 27 required for any of the eight Content Areas) can be IS electives.

- 67-301 Networks and Telecommunications
67-304 Database Design and Implementation
67-305 Application Software Development in .NET
67-320 Special Topics in Information Systems
67-325 Global Systems Delivery Models
67-390 Independent Study in Information Systems
67-xxx Other IS Electives (as approved by the IS program)

A. Organizations

The focus of this content area is on how organizations, ranging from small groups of individuals to society at large, can be transformed by information technology. Students will develop a greater understanding of how to create effective information systems to meet key organizational needs, and how social policy can influence this outcome. Such knowledge can be readily applied by students pursuing careers in both the private and public sectors.

Complete courses to bring total to 27 units (generally three courses)

- 15-390 Entrepreneurship for Computer Science
45-392 Human Behavior in Organizations
45-453 Organizational uses of information systems
67-344 Organizational Intelligence in the Information Age
70-311 Organizational Behavior
70-341 Organizational Communication
70-342 Managing Across Cultures
70-414 Technology-Based Entrepreneurship
79-342 Technology, Organization, and Information
88-260 Organizations
88-341 Organizational Communication
88-354 Economics and Psychology of Organizational Communication
88-367 Computers and Organizations

B. Decision Science and Rational Choice

This area focuses on the decision making component of information systems, taking into account the social, political, and ethical issues in an information-driven society. We need to understand the technical complexities of economic, political, and statistical analysis, but we have also to reflect on basic moral and political values.

This area builds on the analytic rigor of the social sciences and the enduring normative questions of philosophy to promote a critical understanding of the way that information technologies shape the contemporary world.

Complete courses to bring total to 27 units (generally three courses)

19-448	Science, Technology and Ethics
36-350	Data Mining
73-251	Economic Theory
80-211	Arguments and Inquiry
80-230	Ethical Theory
80-305	Rational Choice
80-341	Computers, Society, and Ethics
80-405	Game Theory
88-220	Policy Analysis I
88-223	Decision Analysis and Decision Support Systems
88-302	Behavioral Decision Making
88-385	Managerial Decision Making

C. Research Methods

Understanding how data and information are acquired is an important first step to solving information problems. Moreover, discerning the patterns and trends in data can help guide an organization's information strategy. Research methods provide a basis for students seeking to understand these fundamental issues.

Complete courses to bring total to 27 units (generally three courses)

36-202	Statistical Methods
36/70-208	Regression Analysis
36-350	Data Mining
36-303	Sampling, Surveys, and Society
36-309	Experimental Design for Behavioral & Social Science
36-310	Fundamentals of Statistical Modeling
36-401	Modern Regression
36-410	Introduction to Probability Modeling
36-46x	Topics Courses in Statistics
70-208	Regression and Forecasting
70-481	Market Research
80-222	Measurement and Methodology
80-316	Probability and Artificial Intelligence
80-321	Causation and Social Policy
88-251	Empirical Research Methods

D. Professional Communications

These courses help information systems designers understand how the structure and presentation of information affects how well (and how easily) it can be understood and used. Students become fluent in both electronic and print-based media and learn the fundamentals of visual, verbal, and on-line publication. In addition, information systems professionals are often called to facilitate communications between software engineers and non-technical business clients; consequently, the most successful information systems professionals are typically those with strong communication skills.

Complete courses to bring total to 27 units (generally three courses)

36-315	Graphics and Visualization
51-247	Color and Communication [†]
51-251	Digital Prototyping [†]
51-261/262	Communication Design Fundamentals
70-340	Business Communications
70-343	Interpersonal Communication
70-345	Oral Communications
70-346	Written Communications
76-270	Writing in the Professions
76-318	Communicating in the Global Marketplace
76-373	Argument
76-382	Multimedia Authoring I
76-383	Multimedia Authoring II
76-389	Grammar of Standard English
76-390	Style
76-391	Document Design
76-395	Science Writing
76-479	Marketing, Public Relations and Corporate Communications
76-481	Writing for Multimedia

76-487	On-line Information Design (76-488 lab section not required)
76-491	Software Documentation
80-291	Issues in Multimedia Authoring

[†] Registration for course requires prior acceptance into the Design Minor.

E. Business/Economics

Information systems professionals who understand the nature of business and the financial considerations facing today's companies provide great value to their organizations. The courses within this content area are designed to broaden a student's knowledge in business and economics and to allow them to be as adept working with business clients as they are with software engineers.

Complete courses to bring total to 27 units (generally three courses)

21-292	Operations Research I
21-380	Introduction to Mathematical Modeling
21-393	Operations Research II
21-420	Continuous-Time Finance
36-410	Stochastic Modeling
70-201	Professional and Service Projects
70-332	Business and Society
70-368	Intellectual Property and E-Commerce
70-371	Production and Operations Management
70-381	Marketing
70-391	Finance
70-401	Management Game
70-414	Technology-Based Entrepreneurship
70-459	Distributed Virtual Business
70-460	Mathematical Models for Consulting
70-471	Logistics and Supply Chain Management
73-251	Economic Theory
73-325	Experimental Foundations of Equilibrium
73-359	Benefit-Cost Analysis
73-469	Economics of E-commerce
79-230	Technology in American Society
79-440	Perspectives on Industrial Research and Development
79-441	Science, Technology, and Business in U.S. History
80-241	Ethical Judgments in Professional Life
80-335	Philosophy, Politics, and Economics
88-223	Decision Analysis and Decision Support Systems
88-345	Rise of Industrial Research and Development

F. Computers and Cognition

The area of computers and cognition explore questions of how people think and learn, how computers affect the human learning process and how computers themselves might be able to learn. Courses in this area also investigate how human-computer interaction affects interface design and systems development.

Complete courses to bring total to 27 units (generally three courses)

05-410	Introduction to Human-Computer Interaction Methods
05-411	Cognitive Modeling
05-430	Programming Usable Interfaces
05-431	Software Architectures for User Interfaces
15-381	Artificial Intelligence
15-482	Human Language Technologies
39-648	Wearable Computer Design
51-241	How People Work: Human Factors [†]
51-421	Visual Interface Design [†]
80-271	Philosophy and Psychology
80-300	Minds, Machines, and Knowledge
85-211	Cognitive Psychology
85-213	Human Information Processing and Artificial Intelligence
85-370	Perception
85-392	Human Expertise
85-393/	
05-413	Human Factors
85-412	Cognitive Modeling
85-417	Intelligent Computer-Assisted Instruction

[†] Registration for course requires prior acceptance into the Design Minor.

G. Technology

Of the three components of information systems—people, process, and technology—it is the latter that is in the greatest state of flux. This content area allows students to focus on a particular area of technology that has special interest for them.

Complete courses to bring total to 27 units (generally three courses)

03-310/410	Introduction to Computational Biology
05-331	Building Virtual Worlds
09-560	Molecular Modeling and Computational Chemistry
15-211	Fundamental Data Structures and Algorithms
15-212	Principles of Programming
15-213	Introduction to Computer Systems
15-312	Foundations of Programming Languages
15-354	Computational Discrete Mathematics
15-384	Robotic Manipulation
15-385	Computer Vision
15-410	Operating System Design and Implementation
15-411	Compiler Design
15-412	Operating System Practicum
15-415	Database Applications
15-418	Parallel Computer Architecture and Programming
15-441	Computer Networks
15-451	Algorithm Design and Analysis
15-462	Computer Graphics
15-463	Rendering and Image Processing
15-493	Special Topic: Computer Game Programming
15-499	Media Technology
15-505	Special Topic: Animation Art and Technology
15-681	Artificial Intelligence: Machine Learning
16-311	General Robotics
16-362	Mobile Robot Programming Laboratory
16-363	Advanced Mobile Robot Programming
17-651	Models of Software Systems
18-240	Fundamentals of Computer Engineering
18-447	Introduction to Computer Architecture
33-241	Introduction to Computational Physics
51-442	Integrated Product Development [†]
60-414-422	Advanced Electronic Time-based Art
67-304	Database Design and Implementation
67-305	Application Software Development in .NET
85-419	Introduction to Parallel Distributed Processing

[†] Registration for course requires prior acceptance into the Design Minor.

H. Global Systems

The rise of global project management and systems development increases the need for information systems professionals to develop skills essential for participating in the international marketplace. This content area exposes students to contemporary issues and practices facing organizations, managers and individuals working on a global scale across political, cultural, temporal and geographic boundaries.

Complete courses to bring total to 27 units (generally three courses)

15-391	Technology Consulting in the Community
15-502	Technology for Developing Communities
67-325	Global Systems Delivery Models
67-326	Global Project Management
70-365	International Trade and International Law
70-430	International Management
70-480	International Marketing
73-371	International Trade and Economic Development
73-372	International Money and Finance
76-318	Communicating in the Global Marketplace
76-386	Language and Culture
76-442	Communication across Cultures
79-270	Chinese Culture and Society
79-271	Modern China
79-289	Development and Democracy in Latin America
79-290	Between Revolutions: The Development of Modern Latin America
79-350	Theories of International Relations
82-333	Introduction to Chinese Language and Culture
82-383	Introduction to Second Language Acquisition
82-433	Topics in Contemporary Culture in China
82-487	On Writing in a Second Language
85-375	Cross Cultural Psychology
88-326	International Relations
88-327	Politics of Economic Development
88-352/	
79-346	International Environmental Law and Policy
88-359	Globalization
88-378	International Economics

Information Systems, B.S. Sample Curriculum

Freshman Year		Sophomore Year	
Fall	Spring	Fall	Spring
Interpretation & Argument 76-101	Intro to World History 79-104	Information Systems Milieux 67-250	Application Design and Development 67-272
Statistical Reasoning 36-201	Statistical Methods 36-202 (Disciplinary Core Course)	Disciplinary Core Course	Disciplinary Core Course
Calculus Sequence I	Calculus Sequence II	Elective	Elective
Programming 15-100	Programming 15-200	Elective	Elective
Computing @ Carnegie Mellon & IS Freshman Workshop	H&SS Freshman Seminar	Elective	Elective
Elective	IS Freshman Colloquium 67-101		

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Fundamentals of Systems Development 67-271	Software Development Project 67-373	Information Systems Applications 67-475	Elective
Disciplinary Core Course	Content Area Course	Content Area Course	Content Area Course
Disciplinary Core Course	Elective	Elective	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

The Major in Linguistics

Mandy Simons, Director
Office: Baker Hall 155E
Email: simons@andrew.cmu.edu

Linguistics is the study of human language, and it encompasses a broad spectrum of research questions, approaches and methodologies. Some linguists are concerned with the cognitive aspects of language learning, production and comprehension; some are concerned with language as a social and cultural phenomenon; others engage in the analysis of linguistic form and meaning, some from a functional and others from a formal perspective. There are also computational approaches to linguistics with both applied and theoretical goals.

The Major in Linguistics reflects the multidisciplinary character of the field and of the Linguistics faculty here at Carnegie Mellon, offering a program which provides students with the fundamental tools of linguistic analysis while maintaining a focus on the human context in which language is learned and used. After completing their core courses, students can follow a concentration in one of three areas: Language in its Social Context, Language and Mind, or Language and Communication. Various specialized electives, including Language Technology courses, are available to students with the appropriate preparation. Students can choose to focus fairly narrowly on an area of particular interest, or to explore more widely.

The Major in Linguistics is available as either a primary major or an additional major. It is an ideal choice for students with a general interest in their own or other languages, and combines well thematically with studies in any of the departments represented in the major.

Curriculum

I. Required Courses

A. Fundamental skills (36 units)

Complete one course from each of the groups below. Additional courses from these groups may be taken as electives.

Introductory Course

80-180 Nature of Language

Sounds

80-282 Phonetics and Phonology

Structure

80-280 Linguistic Analysis

or

76-389 Rhetorical Grammar

Meaning

80-381 Meaning in Language

or

76-385 Discourse Analysis

B. Language requirement (18-24 units)

Complete 2 semesters of language study in a single language. (Sequential courses)

II. Electives (45 units)

The electives are organized into three thematically coherent groups: Language in Its Social Context, Language and Mind, and Language and Communication. There is an additional set of specialized electives.

Students must complete 5 elective courses. At least three courses must be selected from one thematic group. The remaining two courses can be selected from any group or from the specialized electives. Additional Fundamental Skills courses may also be taken towards the required electives.

Group 1: Language in Its Social Context

76-244 World English
76-318 Communicating in the Global Marketplace
76-341 American English
76-386 Language and Culture
76-451 Topics in Language Study*
76-490 Discourse and Identity
82-358 Literacies across Language and Culture
82-483 Topics in Modern Languages*

82-384 Language and Culture: Language in its Social Context
82-388 Understanding Second Language Fluency
82-480 Social and Cognitive Aspects of Bilingualism
82-585 Pragmatics and Second Language Learning
82-891 Second Language Acquisition in a Study Abroad Context

Group 2: Language and Mind

76-420 Process of Reading and Writing
80-281 Language and Thought (Philosophy)
80-380 Philosophy of Language
82-483 Topics in Modern Languages*
82-280 Learning about Language Learning
82-383 Second Language Acquisition
82-480 Social and Cognitive Aspects of Bilingualism
85-354 Infant Language Development
85-356 Music and Mind: the Cognitive Neuroscience of Sound
85-421 Language and Thought (Psychology)
85-455 The Discovery of Spoken Language

Group 3: Language and Communication

76-318 Communicating in the Global Marketplace
76-357 Language, Power and the Law
76-381 Contemporary Rhetorical Theory
76-451 Topics in Language Study*
76-457 Topics in Rhetorical Study*
76-490 Discourse and Identity
80-380 Philosophy of Language
82-388 Understanding Second Language Fluency
82-483 Topics in Modern Languages*
82-585 Pragmatics and Second Language Learning

* A variety of different topics are taught under these course numbers. The suitability of the course as an elective in a given group will depend on the specific topic. Students should consult with the faculty advisor.

Specialized Electives

Courses in this group have prerequisites outside the Linguistics Major, but may be taken by any students with appropriate background.

82-777 The Japanese Language
82-334 Structure of Chinese
82-373 Structure of the Japanese Language
82-444 Structure of Spanish
85-356 Music and Mind: the Cognitive Neuroscience of Sound
11-4xx Introduction to Natural Language Processing
11-582 Language Technologies
11-521 Grammars and Lexicons
11-531 Machine translation
11-541 Information Retrieval
11-552 Speech: Phonetics, Prosodics, Perception, and Synthesis
11-722 Grammar Formalisms

III. Senior Thesis (12 units)

In their senior year, typically in the Spring semester, students must complete a senior thesis under the direction of a faculty member of their choosing. The thesis project must be of a scope appropriate for the 12-unit course credit. Students who participate in the Honors program may combine their Honors thesis and Major thesis, as long as the thesis is of appropriate scope.

Students for whom Linguistics is an additional major may substitute an additional elective for the Senior Thesis requirement after consultation with the Faculty Advisor.

The Major in Russian Studies

Faculty Advisor: Charlene Castellano,
Department of Modern Languages
Main Office: Baker Hall 160

The relationship between Russia and the West has been central to the history of the twentieth century, and it continues to influence politics throughout the globe. The rise in fascism, World War II, the Cold War, revolutions in Cuba, Korea, China and Vietnam, and de-colonization struggles in Africa cannot be understood apart from Russian influence. The study of Russia is thus central to our understanding of the present world order and international relations. The disintegration of the USSR, the emergence of more democratic forms of government, and the development of new "free market" economies have led not only to greater openness and stronger ties with the West, but also to a host of new questions in the areas of business, science, technology, national defense and international security. The end of the Cold War allows for exploration of new issues in fascinating ways that were formerly forbidden. The proliferation of exchange programs, the increased accessibility of libraries, archives, and information, and the development of a free press all open untried and exciting possibilities and opportunities for students and scholars. Young, talented people with a broadly-based knowledge of Russian history, language and culture are needed to fill jobs in international law, education, diplomacy, business, journalism and computing, as well as in economic, scientific and technical consulting. The Russian Studies Program aims to give students a solid background in the fields of Russian history, language, culture and politics, by offering a major and minor specialization to interested students.

Russian Studies, a B.A. Program, is jointly administered by the Departments of History and Modern Languages in the College of Humanities and Social Sciences. It is designed for students from all the Carnegie Mellon undergraduate colleges. It may be taken as either a primary major, additional major, or minor.

Russian Studies Major 93 - 96 units

The History Curriculum 27 units

For majors, there is a three-course History requirement comprised of one required course and two courses selected from a list of electives.

1. Core Course(s) in History 9 units

Complete one course.

79-280 Russian History from the First to the Last Tsar*
79-281 Modern Russian History: From Communism to Capitalism*

* Both courses are recommended.

2. Required Electives in History 18 units

Complete two courses. (Substitutions by advisor's permission)

79-282 Soviet Union in World War II: Military and Political History
79-344 The Cold War and Beyond

The Language and Culture Curriculum 45 units

Complete the two prerequisite courses, two intermediate courses and one advanced course.

3. Prerequisite Courses in Modern Languages 24 units

82-191 Elementary Russian I (or demonstrated equivalent)
82-192 Elementary Russian II (or demonstrated equivalent)

4. Core Courses in Modern Languages 27 units

82-291 Intermediate Russian I
82-292 Intermediate Russian II
82-391 Advanced Russian I

Should a student enter the Russian Studies Program with a demonstrated language proficiency at any of these "Intermediate" or "Advanced" levels, the required total of 27 units is reached by selecting from among the advanced language options appearing below in the list of "Required Electives". Advanced language options include "Advanced Russian II" and "Special Topics: Russian", as well as subject-oriented language supplements to existing courses (taught in English) in a variety of fields. Thus students can add a

language supplement (3 units) to selected 9-unit electives, earning a total of 12 units for the language-supplemented course.

5. Required Electives 18 units

Complete two courses.

History

79-205 20th Century Europe
79-231 American Foreign Policy: 1945-Present
79-280 Russian History from the First to the Last Tsar
79-281 Russian History
79-282 Soviet Union in World War II: Military and Political History
79-344 Science and Technology and the Cold War

Modern Languages

82-296 A Century of Russian Film
82-392 Advanced Russian II
82-396 The Faust Legend at Home and Abroad
82-397 Russia's Demons
82-399 Special Topics: Russian
82-491 Topics in Twentieth Century Russian Literature
82-492 The Historical Imagination in Nineteenth-Century Russian Literature
82-493 Joseph Brodsky in Context

New courses will be added as appropriate.

6. Required Independent Research 3-6 units

Complete one course.

82-599 Russian Studies Thesis

In the senior year, majors are required to undertake an independent research or translation project in which their language skills are applied to Russian-language materials. This project, which earns 3 to 6 units, is conducted in connection with an existing course in Russian history, language, literature or politics. The student works closely with the professor to select a topic requiring the use of Russian sources suitable to the student's proficiency level. For example, students may choose to prepare a translation of a little-known piece of Russian literature or a debate from a nineteenth-century journal, to compare Soviet and Western newspaper coverage of the Cuban missile crisis, to research Russian opinion of American race relations, or to read and evaluate the reviews of a popular Russian novel.

7. Study Abroad

Students in both the major and minor programs are encouraged to spend a semester or summer in Russia via an approved exchange program. Many exchange programs offer instruction in Russian language, history, literature, and culture, in internationally recognized universities. They also offer travel to ancient sites and cities, visits to museums, palaces, exhibitions, and monuments, and the opportunity to live with a Russian host family. Scholarship monies are frequently available.

Faculty Exchange Program

In 1993, the College of Humanities and Social Sciences initiated a faculty exchange program with the Russian State University of the Humanities (RGGU), one of the foremost universities in Russia, located in Moscow. Carnegie Mellon has hosted faculty members from RGGU specializing in history, language and philosophy. These professors have joined our College departments for a semester, offering unique courses and perspectives not generally available to our students. In the past, these Russian visitors have offered courses on the Russian Civil War as well as advanced language and literature courses. Several faculty members from Carnegie Mellon have visited Moscow, using the RGGU exchange to pursue archival research and collaborative projects. The exchange offers students an opportunity to study language from native speakers, gain exposure to different perspectives on history and politics, and gather firsthand knowledge about recent developments in Russia. In addition, the exchange can provide important contacts for students interested in pursuing careers abroad.

Russian Studies, B.A.

Sample Curriculum

This sample curriculum assumes that all prerequisites for 82-291 are fulfilled prior to the Junior year.

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Intermediate Russian I 82-291	Intermediate Russian II 82-291	Advanced Russian I 82-391	Russian Studies Thesis 82-599
Core Course in History 79-280/281	Required Elective in History	Required Elective	Required Elective
Elective	Required Elective	Elective	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years, not that it must be. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the first year. Students should consult their advisor when planning their program.

This plan is an example of the suggested sequence of study for students who have had little or no prior exposure to the language. Such students would need to satisfy the prerequisites (elementary and intermediate language study) during their freshman and sophomore years. Students who arrive at Carnegie Mellon with previous language study and/or who have high AP or CEEB scores will be able to begin taking courses toward the major earlier in their undergraduate program and will also be able, should they so desire, to complete an additional major. In all cases, progress toward the major will be accelerated by study abroad which is strongly recommended for all majors.

Additional Major

All Russian Studies Program requirements for an additional major are the same as those for students obtaining the major in Russian Studies (B.A.).

Student-Defined Major Program

Joseph E. Devine, Associate Dean, H&SS Academic Advisory Center
Office: Baker Hall A57

For H&SS students whose educational goals cannot be as adequately served by the curricula of existing majors. The College provides the opportunity to self-define a major. The procedure for establishing such a major centers on a written proposal, submitted to the College's Dean's Office (c/o the H&SS Advisory Center). This proposal, which is to be built on the College's General Education Program, consists of two parts:

Major Description and Rationale. A description of the components of the proposed program of study; a presentation of the objectives of the program of study, why it represents a coherent and (given available faculty, courses, and other resources) viable course of study, and the reason(s) why these objectives cannot be accomplished within one or more of the College's existing majors.

The Curriculum. Presentation of a complete outline of all courses that will comprise the requirements for the major. These courses should be categorized in two ways: first, according to that component of the major program to which each belongs (e.g., mathematical prerequisites; research methods; theoretical perspectives; etc.) and second, a semester-by-semester outline that indicates when each course is to be taken (or, for any already taken, when taken and grade received). In addition to courses taken at Carnegie Mellon, the major's curriculum may include courses taken (or to be taken) at other schools, related projects or internships, or programs of study abroad. The minimum requirements for graduation is, as with all majors in the College, 350 units of credit.

Proposals and curricula are evaluated for clarity of focus, coherence and depth in related areas, and viability within the content of the College and the university. Proposals should generally be developed no later than the sophomore year, and approved majors begin their program generally no later than the junior year. All Student-Defined Majors must complete the H&SS General Education Program.

Additional details and guidelines for the Student-Defined Major program are available in the College's Academic Advisory Center, Baker Hall A57.

H&SS Interdepartmental Minors

H&SS interdepartmental minors are programs whose content and components span two or more academic departments in the humanities, behavioral sciences, and social sciences to form coherent patterns of study.

A number of interdepartmental minors are offered by H&SS, and are, in general, available to all Carnegie Mellon undergraduate students. As well, there are numerous other minors offered by other colleges in the university that are generally available to H&SS students. The full list of minors available to Carnegie Mellon students is located in the catalog index under "Minors."

Completion of the requirements for any of these minors is noted on the final transcript and diploma.

To declare an H&SS interdepartmental minor, students should contact the H&SS Academic Advisory Center (AAC) and the faculty advisor for that minor. Progress is monitored through the faculty advisor and completion of the minor through the H&SS AAC.

To discuss the possibilities of declaring other non-H&SS minors contact the advisor listed for that particular minor.

In general, unless noted, no course taken to fulfill requirements for these interdepartmental minors may be applied toward any other requirements for a major(s) or minor(s).

The Minor in African and African American Studies

Edda L. Fields-Black, Faculty Advisor
Undergraduate Advisor: Naum Kats
Office: Baker Hall 240

Mission

The African and African American Studies minor will expose students to the following regions: sub-Saharan Africa, the Americas, and the Caribbean. Broad geographic coverage and a comparative framework encourage students to make connections between Africa and the African Diaspora, as well as among Diasporan communities. The minor offers undergraduate students the opportunity to undertake an empirical and theoretical examination of the cultural, political, social, and historical experiences of Africans and people of African descent. This unique minor brings together departments and colleges within the university and allows students to develop analytical skills particular to the arts, humanities, social sciences, public policy, and management. The African and African American Studies minor is also designed to allow students a considerable degree of freedom in their choice of electives and independent research projects, including opportunities to study and conduct research in a relevant foreign language.

Requirements

- The minor is composed of 54 units — two core courses and four elective courses.
- Students may take an additional two core courses as electives, but not more than four total courses.
- Students must take courses in at least two of the four regions (African, African American, Latin American, and the Caribbean) between their core and elective courses.

Core Courses (18 units)

African

- 79-356 Introduction to African History I: Earliest Times to the Origin of the Slave Trade
79-258 Introduction to African History II: 18th Century to Neo-Colonialism

African-American

- 76-332 African-American Literature in the 20th and 21st Century
79-241 African-American History I
79-242 African-American History II

Caribbean

- 79-253 The Development of Caribbean Culture

Elective Courses (36 units)

African

- 79-162 Freshman Seminar: 'Slavery' and 'Freedom' in African History?
79-267 Pre-Colonial West African History: 1100 to 1800
79-268 From the Local to the Global: Globalization in East African History
79-294 The Making of African Diaspora in the New World *
79-301 African Entrepreneurs / Entrepreneurs in Africa: Past, Present and Future *
79-317 Historical Memory and Historical Sources: Reconstructing Africa's Unwritten Past *
82-304 The Francophone World **
88-370 African Politics

African-American

- 60-391 Special Topic: Hip Hop and Contemporary Art *
57-480 History of Black American Music *
76-144 Freshman Seminar: The War Against Cliché
76-332 Zora Neale Hurston: In and Out of Context
79-158 Freshman Seminar: Slavery and Emancipation in the Americas
79-286 African Americans in Pittsburgh
79-306 African American Urban History
79-359 History of African American Families *
79-382 African-American Women in US History *

Caribbean

- 76-335 Black' in the Union Jack *
79-294 The Making of African Diaspora in the New World*
79-297 Freedom Bound: Slavery/Emancipation in Brazil & the Caribbean, 1789-1940
79-389 Topics in Anthropology: Caribbean Culture
82-188 Freshman Seminar: The Uses and Abuses of Haiti
82-304 The Francophone World **
82-451 Studies in Latin American Literature & Culture – Cuba: Between Empire and a Hard Place * **
82-454 The Hispanic Caribbean: Floating Continents, Whispering Voices; Rhyme, Reason and Song **

Latin American

- 79-297 Freedom Bound: Slavery/Emancipation in Brazil & the Caribbean, 1789-1940
79-364 Art, Anthropology, and Empire

(Footnotes)

* Denotes courses that require a research paper/project and fulfill requirement for project course

** Denotes courses taught in a foreign language

The Minor in Environmental Studies

Faculty Advisor: Peter Madsen
Office: Baker Hall 161F

Human activities can have large-scale and long-term consequences for environmental quality. The thoughtful analysis of these consequences is required if we desire a sustainable society. The minor in Environmental Studies is designed to provide students with the interdisciplinary background and skills necessary to understand environmental issues. It emphasizes three general areas: humanities, social sciences, and technology and natural science. The humanities emphasis concerns the ethical, legal, and historical basis of environmental concerns. The social science area concentrates on the economic and political nature of environmental problems. The technology and natural science focus includes the exploration of the biological, chemical, and physical nature of the environment and the role of technology in both problem creation and problem solution.

Curriculum 54-73 units

The minor in Environmental Studies is offered jointly by the Departments of History and Social and Decision Sciences, with participation by selected departments from the Mellon College of Science and the Carnegie Institute of Technology. The minor requires that students take Biology and Chemistry in the Mellon College of Science or approved environmentally-related science courses at the University of Pittsburgh. In addition, minors are required to complete two required core courses, three intermediate (distributional) courses spread across at least two of the areas of emphasis, and one advanced course. The advanced course requirement includes either pre-approved sections of Policy Analysis III or pre-approved sections of the History and Policy Project Course. It is important for students to work closely with the faculty advisor for the minor in order to select the proper mix of courses to fulfill requirements.

With the exception of the minor's science prerequisites, courses taken to fulfill requirements in other major or minor programs may not be applied to the Environmental Studies minor requirements (and vice versa). In the case of the minor's "Advanced Course" requirement, if one of the two advanced courses is being taken to fulfill a requirement for another program, it cannot also be applied to this minor requirement. If it is not possible to take the other advanced course option, the faculty minor advisor will work with the student to identify an alternative course for this requirement.

NOTE: The courses listed below are offered with at least general regularity. Participating departments may subsequently develop and offer other courses that, while not listed here, are deemed appropriate for this minor. The minor faculty advisor should be consulted (especially when the schedule of courses to be offered for a given semester becomes available) to identify such additional courses.

Science Prerequisites* 19 units

03-121 Modern Biology
09-105 Modern Chemistry I or approved environmentally-related science courses (equivalent to at least 18 Carnegie Mellon units) at the University of Pittsburgh (see faculty minor advisor)

*These science courses may double count with other major and minor requirements.

Required Courses 18 units

66-210 Science and Technology for the Environment
80-244 Management, Environment, and Ethics

Intermediate (Distributional) Requirements 27 units

Complete three courses in at least two of these areas: Science and Technology, Social Science, and Humanities. Only one of the three courses can be an introductory course (as indicated below by an asterisk).

Science and Technology Area

12-100 Introduction to Civil and Environmental Engineering*
12-655 Water Quality Engineering
12-651 Air Quality Engineering
19-101 Introduction to Engineering and Public Policy*
19-222/223 Sustainability (6 units)
19-321 Environmental Management (6 units)
19-321 Law and Technology
19-422 Radiation, Health, and Policy
19-448 Science, Technology and Ethics

24-297 Energy-Environmental Systems
42-424 Biological Transport

Social Sciences Area

73-357 Regulation: Theory & Policy
73-358 Economics of the Environment and Natural Resources
88-220 Policy Analysis I
88-221 Policy Analysis II
88-425 Politics of Economic Deregulation

Humanities Area

76-319 Environmental Rhetoric
79-346 International Environmental Law and Policy
79-384 Medicine and Society

Advanced Course (minimum) 9 units

Both courses listed in this category have prerequisites or, as an alternative, require instructor approval for entry.

88-222 Policy Analysis III (pre-approved sections)
or
79-410 History and Policy Project Course (pre-approved sections)

The Minor in European Studies

Faculty Advisor: Beryl Schlossman, Department of Modern Languages
Office: Porter Hall 125A

Offered jointly by Modern Languages and History, the Minor in European Studies is a unique interdisciplinary program that seeks to develop and enhance students' understanding of European societies and cultures. It aims to train students in literature and language, cultural history and the arts, as well as related areas of professional opportunity. It offers substantive knowledge of Western European society through two approaches. First, it provides a foundation in one of the continental Western European languages. Second, it encourages comparative inquiry across boundaries of time, nation, and scholarly discipline.

Curriculum 54 units

Offered jointly by the Departments of Modern Languages and History.

European Studies minors must take two prerequisite courses (18 units) in the same foreign language (French, Spanish, or German) or demonstrate the equivalent in language ability through the Carnegie Mellon Language Placement Test. The requirements include a minimum of 54 units of core courses. Students are encouraged to take advantage of the Study Abroad Program.

Students are urged to check with the Minor Advisor in selecting courses for this major.

I. Core Courses in Modern Languages 27 units

Language courses are to be completed in the same language: French, German, or Spanish.

Complete two courses in a 200-level language sequence*
18 units

82-2xx 200-level language course
82-2xx 200-level language course

*Students who place out of 200-level language courses must take at least two 300-level courses or a combination of 300 and 400 level language courses.

Complete one course in a 300-level language course 9 units

82-3xx 300-level language course

II. Core Courses in History 27 units

Required Course 9 units

79-207 Development of European Culture

Pre-20th Century European History 9 units

Complete one 200-level (or above) course in Pre-20th century European history.

79-2xx/3xx Pre-20th century European History course

European History 9 units

Complete one 300-level course in European history.

79-3xx European History course

The Minor in Film and Media Studies

Faculty Advisor: David Shumway
Office: Baker Hall 259

Film and the electronic media have become a crucial part of contemporary culture and society; they constitute an important tool for understanding social arrangements, historical changes, and play an increasingly important role in the development of aesthetic and cultural theory. The H&SS minor in Film and Media Studies takes an interdisciplinary approach to the study of film and other electronic media. Courses provide techniques for analyzing and criticizing film and other media, for assessing their value as historical, anthropological and social scientific data, and for understanding the aesthetic and philosophical premises of various media texts. In addition, students may take courses in the processes of filmmaking, offered through special arrangement with the Pittsburgh Filmmakers (a non-profit media arts center, operating since 1971, that provides workshops, seminars, screenings, exhibitions, and training programs in the media and photographic arts).

Courses taken to fulfill requirements for other major or minor programs may not be applied to the Film and Media Studies Minor requirements.

Curriculum 54 Units

The courses listed below are offered with at least general regularity. Participating departments may subsequently develop and offer other courses that, while not listed here, are deemed appropriate for this minor. The minor faculty advisor should be consulted (especially when the schedule of courses to be offered for a given semester becomes available) to identify such additional courses.

Introductory Course 9 Units

76-239 Introduction to Film Studies
(prerequisite for 76-439)

Required Intermediate Course 9 Units

76-339 Advanced Studies in Film and Media
(May be taken up to three times and counted for additional credit toward Intermediate Courses if topics differ)

OR

76-361 Film Festival Course

Intermediate Courses 18 Units

Complete a minimum of 18 units of course work, chosen in any combination from the following three course groups. (All courses are 9 units unless otherwise indicated).

1. Film and the Study of Society

76-238 Introduction to Media Studies
82-296 A Century of Russian Film
82-187 French Cinema

2. Film and Anthropology

79-303 Visual Anthropology

3. Filmmaking

76-269 Study of Forms: Screenwriting
FM 200 Intermediate Filmmaking (please go to CFA 100 to register for this course)

Other 200 or 300 level courses in English, History, and Modern Languages can be counted in this category when their primary topic is film and media. Please consult the minor faculty advisor.

Advanced Courses 9 Units

Complete one advanced course which concentrates on film directly or which uses it as a tool of social or cultural analysis.

FM 301 Advanced Filmmaking (please go to CFA 100 to register for this course)
76-439 Advanced Seminar in Film and Media
76-437 The American Cinema
76-438 Advanced Seminar in American Literacy and Cultural Studies
76-469 Screenwriting Workshop
82-491 Literature, Politics and Film in East Europe and Russia Today

The Minor in Gender Studies

Faculty Advisor: Kristina Straub
Office to declare minor: English, Baker Hall 259

Gender Studies is an interdisciplinary field that investigates how gender is embedded in social, cultural, and political relationships. It understands gender as a category of power that intersects with other power relations, including race, class, and sexuality. Courses allow students to develop a deeper understanding of how gender operates, and to transfer the analytical skills they acquire to other courses as well as to their personal and professional lives. The minor combines coursework in English, History, Anthropology, Psychology, Philosophy, Economics, and Modern Languages.

Courses taken to fulfill requirements in other major or minor programs may not be applied to the Gender Studies minor requirements (and vice versa).

Curriculum 54 units

The courses listed below are offered with at least general regularity. Participating departments may subsequently develop and offer other courses that, while not listed here, are deemed appropriate for this minor. The minor faculty advisor should be consulted for approval.

Required Introductory Courses 18 units

Complete one of the following (9 units):
76-241 Introduction to Gender Studies
79-234 Body Politics: Women and Health in America

and

79-379 Women in America

Elective Intermediate Courses 27 units

73-340 Labor Economics
76-241 Introduction to Gender Studies*
76-245 Shakespeare and the Genres
76-330 Medieval Literature: Women's Lives, Men's Lives
76-333 Histories of Sexualities
76-353 Advanced Gender Studies
79-209 Theory and Practice in Anthropology
79-234 Body Politics: Women and Health in America*
79-236 18th Century China through Literature
79-253 Development of Caribbean Culture
79-260 Mayan America
79-270 Chinese Culture and Society
79-284 History of Gender and the Family in Russia
79-294 The Making of the African Diaspora in the New World
79-308 Politics and Culture of Memory
79-320 Women and Power
79-329 Sex, Population and Birth Control
79-348 Objects of Value
79-359 History of African American Families
79-364 Art, Anthropology and Empire
79-379 Women in America*
79-382 African American Women in US History
80-346 Value, Fact, and Policy
85-221 Principles of Child Development
85-352 Evolutionary Psychology
*if not taken as required introductory course

Elective Advanced Courses 9 units

76-435 Theories of Gender and Sexuality
76-435 Feminist Cultural Studies
79-404 Extreme Ethnography
82-407 The Arts in Society: French Modernism

82-413	The Arts in Society: Theaters of Love
82-415	Baudelaire and Modern French Culture
82-415	Writing and Viewing the Other
82-416	Twentieth Century and Contemporary French Literature and Cinema
82-451	Literature and Revolution in Central America
82-456	Madres, machos y más: género y sexualidad en América Latina
85-446	Psychology of Gender

As an alternative, in extenuating circumstances, students may substitute another 9-unit course from the "Intermediate Course" list above with the approval of the minor faculty advisor. Students may also take more than 9 units from the "Advanced Course" list to count for the 54 unit total. For information about additional course offerings, contact Kristina Straub, ks3t@andrew.cmu.edu, 268-6458.

The Minor in Global Systems and Management

Faculty Advisor: Stephen Pajewski
Office: PH 100B

This minor is intended for students wishing to develop skills essential for participating in emerging opportunities in global business systems, systems development, product development and global project management. The minor exposes students to contemporary issues and practices facing organizations, managers and individuals working on a global scale across political, cultural and temporal boundaries. The minor presents an opportunity for students to learn about being part of a global organization that has optimized the geographic locations for completing all its work. Graduates across all disciplines are increasingly likely to find themselves working as part of a global development team on a wide variety of business, consumer, and intellectual products and services. Students will learn about global project management, outsourcing and cross-cultural communications from theoretical and practical viewpoints. An organized elective structure enables students to tailor the minor reflect their specific interests.

Curriculum 54 units

The Minor in Global Systems and Management is offered jointly across the departments and programs of the College of Humanities and Social Sciences with participation from the Tepper School of Business. The minor is administered by the H&SS Information Systems program. The minor requires that students complete a series of three core courses. The core IS courses do not require prerequisites, the other core courses have minimal prerequisites, and all are offered at least once per year. In addition, minors are required to take at least one course in Communications, one or two courses in Humanities, Heritage and Culture and one or two courses in International Management.

Students are encouraged to complete a semester of study abroad. A wide variety of courses completed at appropriate foreign institutions as part of semester abroad can be substituted for the third core course requirement (76-442, 76-483 or 85-375). The minor faculty advisor should be consulted before embarking on the semester of study abroad to identify an appropriate course or courses at the foreign institution that can be used to provide an appropriate substitute for the minor requirement.

Courses taken to fulfill requirements in other major or minor programs may not be applied to the Global Systems and Management minor.

NOTE: The courses listed below appear to be offered with at least general regularity. Participating departments may subsequently develop and offer other courses that, while not listed here, are deemed appropriate for this minor. The minor faculty advisor should be consulted (especially when the schedule of courses to be offered for a given semester becomes available) to identify such additional courses. Additionally, students may develop and submit to the faculty advisor customized plans that substantially meet the requirements of this minor while allowing the student a personally-crafted learning experience. Proposals should generally be developed no later than the sophomore year, and the minor program

started no later than junior year. Proposals will be evaluated for clarity of focus, coherence and depth in areas related to global project development and viability within the context of the College and university. Approval must be obtained prior to embarking on a customized course of study.

Required Courses 18 units
Complete three courses.

67-325 Global Systems Delivery Models (6 units)
67-326 Global Project Management (3 units)
One of the following *:
76-386 Language and Culture
76-442 Communication across Cultures
85-375 Cross Cultural Psychology

*Course may be substituted with an approved course(s) completed as part of a semester abroad. The course taken to fulfill this requirement can only be counted once toward completion of the minor.

Communications 9 units
Complete one course.

76-270 Writing for the Professions
76-318 Communicating in the Global Marketplace
76-386 Language and Culture
76-442 Communication across Cultures

Humanities, Heritage and Culture 9-18 units
Complete courses totaling 9-18 units (generally 1 or 2 courses).

79-270 Chinese Culture and Society
79-271 Modern China
79-288 Bananas, Baseball, and Borders: A History of Latin America-US Relations
79-289 Development and Democracy in Latin America
79-290 Between Revolutions: The Development of Modern Latin America
79-350 Theories of International Relations
79-440 Perspectives on Industrial Research and Development
82-304 The Francophone World
82-323 Germany, Austria and Switzerland in the 20th Century
82-333 Introduction to Chinese Language and Culture
82-383 Introduction to Second Language Acquisition
82-433 Topics in Contemporary Culture in China
82-480 Social and Cognitive Aspects of Bilingualism
82-487 On Writing in a Second Language
85-375 Cross Cultural Psychology

International Management 9-18 units
Complete courses totaling 9-18 units (generally 1 or 2 courses).

15-502 Technology and Global Development
70-342 Managing Across Cultures
70-365 International Trade and International Law
70-430 International Management
70-480 International Marketing
73-371 International Trade and Economic Development
73-372 International Money and Finance
88-326 International Relations
88-327 Politics of Economic Development
88-352/79-346 International Environmental Law and Policy
88-359 Globalization
88-378 International Economics

The Minor in Health Care Policy and Management

Sponsored by:

H. John Heinz III School of Public Policy and Management
College of Humanities and Social Sciences
Mellon College of Science

Faculty Advisors:

Caroline Acker, College of Humanities and Social Sciences
Brenda Peyser, H. John Heinz III School of Public Policy and Management, Amy Burkert, Mellon College of Science

The face of health care is changing. The practice of medicine is being fundamentally altered by the forces of change in public policy, health care organizations and in the industry as a whole. The role of individual professionals in this industry is changing as rapidly as the industry itself. Traditional career paths have disappeared overnight to be replaced by new opportunities that require new skills. New organizations are placing new demands on their professional and medical staffs. The criteria of efficiency and financial stability are entering the domains of diagnosis and treatment.

This minor is designed to provide students considering a career in the health professions with an understanding of how these changes are likely to affect their careers. Students will become familiar with the critical policy and management issues and will begin to learn to operate effectively in the emerging health care environment. The curriculum combines economic, organizational, managerial, historical and psychological perspectives on these issues to provide a foundation for a deepened understanding of the changing structure of health care organizations and policy.

Curriculum (minimum) 60 units

Seven courses (a minimum of 60 units) are required to complete this minor. Entry into the minor requires completion of 73-100, Economics or 88-220, Policy Analysis I or the equivalent by approval.

Required Courses 33 units

Students are required to take the following courses.

79-384	Medicine and Society (9 units)
90-735	Health Economics (12 units)
90-836	Health Systems (6 units)
90-861	Health Policy I (6 units)

Elective Courses 27 units

Complete a minimum of 27 units.

Heinz School Courses

91-830	Financial Management of Health Systems
91-836	Legal Issues in Health Systems Management
91-844	Managing Quality Improvement
91-853	Health Care Information Systems
91-xxx	Health Policy II
91-862	Managed Care

Humanities and Social Sciences Courses (9 units each)

76-494	Healthcare Communications
79-335	Drug Use and Drug Policy
79-336	Epidemic Disease and Public Health
80-245	Medical Ethics
80-247	Health, Development, and Human Rights
85-241	Social Psychology
85-442	Health Psychology
85-446	The Psychology of Gender

Please note that some of these courses have prerequisites that will not count toward the completion of the requirements for this minor.

The Minor in Linguistics

Faculty Advisor: Mandy Simons

Office: Baker Hall 155E

Linguistics is the study of human language. It aims not merely to describe particular languages, but to characterize and account for the nature of language and for the human ability to learn and use it. Linguists address the phenomenon of language from a variety of perspectives. Some are concerned with the cognitive aspects of language learning, production and comprehension; some are concerned with language as a social and cultural phenomenon; others engage in the analysis of linguistic structure, some from a functional and others from a formal perspective. Some linguists are concerned with computational implementations of linguistic theory for both practical and theoretical purposes. In all cases, a central question for linguists is to understand not only the wonderful variety of the world's languages but also what these languages have in common: what it is that makes a human language human. The study of language thus contributes vitally to our understanding of human society, human culture, and human minds.

The interdepartmental Minor in Linguistics is sponsored by the departments of English, Modern Languages, Philosophy and Psychology and the Language Technologies Institute. It synthesizes the linguistics related offerings in these departments and provides students with an academic experience that reflects both the interdisciplinary character of the subject and its cross-departmental representation at CMU.

Curriculum

54 units

Linguistics Minors must complete six linguistics related courses. Of the six, three must be selected from the five core courses listed below. The remaining three courses may be selected from among any of the linguistics related courses taught in the four H&SS departments or the LTI.

Students in the minor may choose to take advantage of the full range of approaches to the study of language represented here, or may choose to focus on a particular aspect of language study. Note, however, that some of the elective courses have particular core courses as prerequisites. Students should take this into account when they select their core courses.

Core Courses

76-386	Language and Culture
80-280	Linguistic Analysis
82-383	Second Language Acquisition
85-421	Language and Thought (Psychology)
11-582	Language Technologies

Note: If more than three courses are taken from this set, the additional ones will count as electives.

Elective Courses

Students must complete three electives, of which two must be 300+ level courses. No 100 level courses are admissible as electives, with the exception of linguistics-related Freshman Seminars. A listing of possible electives is given below, but this list is not intended to be exhaustive. Other courses or seminars on linguistic topics will generally be approved for inclusion. (Students should consult with the Faculty Advisor.) Note: courses taken to fulfill requirements in other major or minor programs may not be applied to the Linguistics Minor requirements (and vice versa).

76-385	Introduction to Discourse Analysis
76-389	Grammar of Standard Written English
76-411	Events
76-451	Topics in Language Study*
80-281	Language and Thought (Philosophy)
80-381	Meaning in Language
80-380	Philosophy of Language
82-280	Learning about Language Learning
82-388	Understanding Second Language Fluency
82-442	Analysis of Spoken Spanish
82-480	Social and Cognitive Aspects of Bilingualism
85-354	Infant Language Development
11-511	Algorithms for Natural Language Processing
11-521	Grammars and Lexicons
11-531	Machine translation
11-541	Information Retrieval
11-552	Speech: Phonetics, Prosodics, Perception, and Synthesis

* A variety of different courses are taught under this number/title. The course may be taken more than once, as long as the topic is different each time.

The Minor in Multimedia Production

Faculty Advisor: Robert Cavalier
Office: Baker Hall 155C

Computers are increasingly being used to present information in non-traditional forms. Of special note is the use of computers for multimedia presentations in which text, graphics, video, and sound are combined, often in interactive formats.

Multimedia applications are expanding as information providers attempt to deliver their message via computers - educators and software developers develop video and graphics applications to supplement and enhance more traditional textual materials, businesses allow browsing and on-line ordering of their products, libraries allow the searching and perusal of their holdings, and organizations promote themselves on the Internet. In fact, multimedia applications on the Internet are so prevalent that World Wide Web addresses can be found throughout the traditional forms of communication - including print, television, and film - directing their audiences to additional, and presumably "enhanced," multimedia materials.

This Minor is specifically designed for undergraduate Liberal Arts majors (including BHA Majors). Its objective is to introduce students in these areas of study to the philosophical and technical aspects of Multimedia Authoring. The three core courses of the Minor will provide Liberal Arts students with the major issues and basic skills necessary to understand and appreciate this new aspect of communication.

Students interested in pursuing this minor must consult the faculty advisor for this minor prior to registering for any of the core courses.

Curriculum 59 units

Required Courses 45 units

15-111	Introductory Intermediate Programming (10 units)
76-270	Writing in the Professions (9 units)
76-382	Multimedia Authoring I (9 units)
76-383	Multimedia Authoring II (9 units)
80-291	Issues in Multimedia Authoring (9 units)

Elective Courses 18 units

In general, relevant electives for the Minor in Multimedia Production will be similar to the core courses and electives of the following University Programs:

The Human-Computer Interaction Major

The Communication and Design Core of the Information Systems Major. The GSIA track in Graphic Communications Management, The Graduate Program in Entertainment Technology

With the advice and approval of the minor faculty advisor, students may propose courses other than those listed, provided they can show that these courses will enhance their knowledge of issues relating to multimedia production.

The Minor in Religious Studies

Faculty Advisor: David Miller,
Undergraduate Advisor: Naum Kats
Office: Baker Hall 240

The Religious Studies minor provides the student with a range of intellectual tools with which to think about religious ideas, behaviors and institutions. A further objective is to enable the student to build a base of knowledge which extends beyond any one particular religious tradition. The minor consists of six courses, totaling at least 54 units.

No more than 9 units of courses in the minor can be double-counted to fulfill requirements for any other minor or major.

Curriculum 54 units

In addition to the general education requirements of the student's college and the requirements of the student's major, Religious Studies minors must satisfy the requirements as outlined below.

The "required" course listed below is offered regularly; the "distribution" and "elective" courses are offered with at least general regularity. Participating departments may subsequently develop and offer other courses that, while not listed here, are deemed appropriate for this minor. The minor faculty advisor should be

consulted (especially when the schedule of courses to be offered for a given semester becomes available) to identify such additional courses.

Core Course 9 units

This required course introduces a variety of methods of religious inquiry such as philosophy of religion, sociological and behavioral approaches to religion, historical analysis of religious subject matter, literary and critical analysis of religious texts, theological modes of thought, and anthropological treatments of religion.

79-259 Introduction to Religion

Distribution Requirements 18 units

Complete two courses that are not from the same disciplinary approaches. Examples are listed below. Please see the faculty advisor for other options. Each of the courses that may be chosen to fulfill this requirement takes a specific disciplinary approach to religion and deals with subject matter which is not specific to one religious tradition.

Historical Approaches

79-222	Religion and American Society
79-225	Religions of China
79-397	Religion and Politics in the Middle East

Philosophical Approaches

80-151	God in the West
80-276	Philosophy of Religion

Textual Approaches

79-325	Art and Religion
76-330	Medieval Literary and Cultural Studies
76-331	Renaissance and Literary and Cultural Studies

Elective Courses (minimum) 27 units

Complete courses totaling at least 27 units. In addition to the Carnegie Mellon courses listed below, electives may be chosen from among any of the courses listed above under "Distribution requirements" that were not used to fulfill that requirement.

66-301	Science and Christianity
79-219	The Holocaust in Historical Perspective
79-220	Early Christianity
79-221	Christendom Divided: The Protestant and Catholic Reformations, 1450-1650
79-251	Flesh and Spirit: Early Modern Europe, 1400-1800
79-275	Religious Identities and Religious Conflicts in Nineteenth-Century Europe

Students may cross-register for relevant electives at other Pittsburgh institutions with the permission of the faculty advisor for the religious studies minor.

The Minor in Russian Studies

Faculty Advisor: Charlene Castellano,
Department of Modern Languages
Main Office: Baker Hall 160

The relationship between Russia and the West has been central to the history of the twentieth century, and it continues to influence politics throughout the globe. The rise in fascism, World War II, the Cold War, revolutions in Cuba, Korea, China and Vietnam, and de-colonization struggles in Africa cannot be understood apart from Russian influence. The study of Russia is thus central to our understanding of the present world order and international relations. The disintegration of the USSR, the emergence of more democratic forms of government, and the development of new "free market" economies have led not only to greater openness and stronger ties with the West, but also to a host of new questions in the areas of business, science, technology, national defense and international security. The end of the Cold War allows for exploration of new issues in fascinating ways that were formerly forbidden. The proliferation of exchange programs, the increased accessibility of libraries, archives, and information, and the development of a free press all open untried and exciting possibilities and opportunities for students and scholars. Young, talented people with a broadly-based knowledge of Russian history, language and culture are needed to fill jobs in international law, education, diplomacy, business, journalism and computing, as well as in economic, scientific and technical consulting. The Russian Studies Program aims to give students a solid background in the fields of Russian history,

language, culture and politics, by offering a major and minor specialization to interested students.

Russian Studies, a B.A. Program, is jointly administered by the Departments of History and Modern Languages in the College of Humanities and Social Sciences. It is designed for students from all the Carnegie Mellon undergraduate colleges. It may be taken as either a primary major, additional major, or minor.

Russian Studies Minor 78 units

The History Curriculum 18 units

For minors, there is a two course History requirement comprised of one required course and one course selected from a list of electives.

The intermediate-level History courses are generally taken in the sophomore and junior years. They provide a substantive overview of the major events and issues in Russian history and policy.

1. Core Course(s) in History 9 units

Complete one course.

- 79-280 Russian History from the First to the Last Tsar*
79-281 Modern Russian History: From Communism to Capitalism

* Both courses are recommended.

2. Required Electives in History 9 units

Complete one course (Substitutions by advisor's permission).

- 79-282 Soviet Union in World War II: Military and Political History
79-344 Science, Technology and the Cold War

The Language and Culture Curriculum 42 units

Complete the two prerequisite courses and two intermediate courses.

3. Prerequisite Courses in Modern Languages 24 units

- 82-191 Elementary Russian I (or demonstrated equivalent)
82-192 Elementary Russian II (or demonstrated equivalent)

4. Core Courses in Modern Languages 18 units

- 82-291 Intermediate Russian I
82-292 Intermediate Russian II

Should a student enter the Russian Studies Program with a demonstrated language proficiency at any of these "Intermediate" levels, the required total of 18 units is reached by selecting from among the advanced language options appearing below in the list of "Required Electives". Advanced language options include "Advanced Russian I", "Advanced Russian II" and "Special Topics: Russian", as well as subject-oriented language supplements to existing courses (taught in English) in a variety of fields. Thus students can add a language supplement (3 units) to selected 9-unit electives, earning a total of 12 units for the language-supplemented course.

5. Required Electives 18 units

Complete two courses.

History

- 79-205 20th Century Europe: Collapse and Renewal
79-231 American Foreign Policy: 1945-Present
79-280 Russian History from the First to the Last Tsar
79-281 Modern Soviet History: From Communism to Capitalism
79-282 Soviet Union in World War II: Military and Political History
79-344 Science, Technology and the Cold War

Modern Languages

- 82-392 Advanced Russian II
82-396 The Faust Legend at Home and Abroad
82-397 Russia's Demons
82-399 Special Topics: Russian
82-491 Topics in Twentieth-Century Russian Literature
82-492 The Historical Imagination in Nineteenth-Century Russian Literature
82-493 Joseph Brodsky in Context

New courses will be added as appropriate.

6. Study Abroad

Students in both the major and minor programs are encouraged to spend a semester or summer in Russia via an approved exchange program. Many exchange programs offer instruction in Russian language, history, literature, and culture, in internationally recognized universities. They also offer travel to ancient sites and cities, visits to museums, palaces, exhibitions, and monuments, and the opportunity to live with a Russian host family. Scholarship monies are frequently available.

The Minor in Science, Technology and Society

Faculty Advisor: Jay Aronson,
Undergraduate Advisor: Naum Kats
Office: Baker Hall 240

This minor provides varied perspectives on the development and meaning of science and technology in modern society. The core courses provide for the exploration of the philosophical underpinnings, cultural and historical contexts, and economic and literary assessments of the interplay among science, technology and society. Elective courses allow students to pursue more deeply subjects and approaches that build on both core courses and students' primary majors.

Courses taken to fulfill requirements in other major or minor programs may not be applied to this minor and vice versa.

Curriculum 54 units

Core Courses 27 units

Complete one course from each of Areas 1, 2 and 3.

Area 1. Language and Rhetoric in Science and Technology (9 units)

- 76-319 Environmental Rhetoric
76-395 Science Writing
76-476 Rhetoric of Science
51-326 Documenting the Visual

Area 2. History, Philosophy and Social Studies of Science and Technology (9 units)

- 79-230 Technology in American Society
79-256 Biology and Society: Evolution, Animal Experimentation and Eugenics
79-296 Genes, Clones, and Stem Cells: Biology and Society in the 20th Century and Beyond
79-333 History of Biomedical Research
79-342 Introduction to Science and Technology Studies
79-358 Complex Technological Systems: Past, Present, and Future
79-384 Medicine and Society
80-225 Birth of Modern Science
80-226 Revolutions in Science
80-323 Philosophy of Biology

Area 3. Disciplines, Practices, Economics and Constituencies in Science and Technology (9 units)

- 12-090 Technology and the Environment
15-502 Technology and Global Development
17-400 Electronic Voting
18-482 Telecommunications, Technology Policy & Management
19-448 Science, Technology, and Ethics
39-100 Special Topics: What is Engineering
48-448 History of Sustainable Architecture
48-572 Zero Energy Housing
66-210 Science, Technology, and the Environment
67-366 Social Issues in Computing
79-234 Body Politics: Women and Health in America
79-248 History and Theory of Property: Land and Bodies, Ideas and Information
79-263 From Soil to Oil: Energy and the Environment in the Americas
79-312 Medical Anthropology
79-329 Sex, Population and Birth Control
79-335 Drug Use and Drug Policy
79-336 Epidemic Disease and Public Health
79-344 Science, Technology, and the Cold War
79-355 The American Skyscraper: Its History and Development
79-440 Perspectives on Industrial Research and Development (cross-listed with 88-345)
79-441 Science, Technology, and Business in U.S. History
80-245 Medical Ethics

80-247 Health, Development, and Human Rights
 80-258 Leibniz, Locke, and Hume
 80-341 Computers, Society, and Ethics
 85-380 In Search of Mind: The History of Psychology
 88-343 Economics of Technological Change

Electives 27 units

Complete three courses from the approved list of elective courses. Courses listed in Areas 1, 2 and 3 may also be taken as electives if not already completed for an Area requirement. For a listing of approved courses, consult the description of the Minor in Science, Technology and Society on the College of Humanities and Social Sciences' webpage (<http://www.hss.cmu.edu/index.html>), or contact the faculty advisor directly at aronson@andrew.cmu.edu.

The Minor in Sociology

Faculty Advisor, Roberto Weber
 Program Advisor, Connie Angermeier
 Office: Porter Hall 208A

The Sociology minor provides the student with a solid introduction to the central concepts in sociological theory and a grounding in the methods of empirical inquiry needed to understand societies, their histories, and how they change over time. Students choose among selected topics including social psychology, work and organizations, social networks, technology and society, medical sociology, and gender and family. Exposure to these topics will help students understand and appreciate the processes by which families, groups, and organizations form and evolve over time; by which individuals affect and are affected by the society in which they live; and by which technology and institutions shape and influence society. This background in empirical tools and social theory will strengthen students' ability to enter graduate studies in sociology, social history, social science, and organizational theory; to begin professional careers involving social analysis, network analysis, data analysis of teams, groups and organizations, social analysis within journalism, political institutions, the government; and to enter the corporate environment with a thorough understanding of organizational activity.

Curriculum 54 units

In addition to the general education requirements of the student's college and the requirements of the student's major, Sociology minors must satisfy the following requirements. The Core courses comprise 18 units of the minor. One course is taken from the Organizations cluster, and one course is taken from the Methodology cluster. The Elective courses comprise 36 units of the minor. Sociology minors should consult with the program advisor to plan a course schedule prior to registration.

NOTE: The core courses are offered regularly; the elective courses are offered with at least general regularity. Participating departments may subsequently develop and offer other courses that, while not listed here, are deemed appropriate for this minor. The program advisor should be consulted (especially when the schedule of courses to be offered for a given semester becomes available) to identify such additional courses.

No more than 9 units in the Sociology minor may be counted to fulfill any other major or minor's requirements.

Core Courses 18 units

a. Organizations

Complete one course.

70-311 Organizational Behavior
 88-260 Organizations

b. Methodology

Complete one course.

36-202 Statistical Methods
 70-208 Regression Analysis
 85-340 Research Methods in Social Psychology
 88-251 Empirical Research Methods

Elective Courses 36 units

Complete four courses from the following list. Two courses (18 units) must be taken from one category to complete the depth requirement. One course (9 units) must be taken from the other category. The remaining course (9 units) may be taken from either category. Appropriate courses offered by the Department

of Sociology at the University of Pittsburgh (available during the academic year through cross-registration) may also be included as part of this option. Contact the Sociology program advisor for more information.

1. Sociology of Gender, Family, and Culture

70-342 Managing Across Cultures
 79-270 Chinese Culture and Society
 79-284 Family and Gender in Russian History
 79-308 The Politics and Culture of Memory
 79-309 Public Policy and American Military Recruitment: Historical Perspective
 79-315 History, Memory, and Patriotism in America
 79-317 Historical Memory and Historical Sources: Reconstructing Africa's Unwritten Past
 79-320 Women and Power
 79-329 Sex Population and Birth Control
 79-332 Juvenile Delinquency: Images, Realities and Public Policy, 1800-1940
 79-338 Childhood, Education and Social Reform in American History
 79-359 History of African-American Families
 79-368 Poverty, Charity, and Welfare
 79-379 Women in American History
 79-382 African-American Women in US History
 79-384 Medicine & Society
 80-230 Ethical Theory
 80-245 Medical Ethics
 80-305 Rational Choice
 85-241 Social Psychology
 85-446 Psychology of Gender

2. Sociology of Work, Organizations, and Technology

70-332 Business, Society, and Ethics
 70-414 Technology-Based Entrepreneurship
 73-432 Economics of Education
 79-230 Technology in American Society
 80-291 Issues in Multimedia Authoring
 80-300 Minds, Machines, and Knowledge
 80-341 Computers, Society and Ethics
 88-222 Policy Analysis III
 88-341 Organizational Communication
 88-347 Complex Technological Systems
 88-371 Entrepreneurship, Technological Change, and Regulation in Theory and Practice

Note: Some courses have additional prerequisites.

Undergraduate Economics Program

Dennis Epple, Head of Economics
 Carol B. Goldberg, Director of Undergraduate Economics
<http://www.tepper.cmu.edu/economics>
 E-mail: econprog@andrew.cmu.edu

At its most fundamental level, economics is the study of how scarce resources are allocated. What will be produced and consumed, how much, and by whom? These questions, central to the well-being of people throughout the world, are the focus of economics. Economists identify, model, and analyze problems, developing meaningful solutions for the challenges confronting society. Economists are also active participants in the processes and institutions through which the pressing concerns of society are addressed. Economists help businesses, political bodies, and other organizations make better decisions through the development of market strategies, the promulgation of regulatory structures, and the formulation of appropriate government policies. Increasingly, economists are taking advantage of new technologies to design and implement new markets and exchange mechanisms.

Carnegie Mellon University enjoys a rich history of innovative research in the field of Economics. By bringing together rigorous theoretical and empirical work, the University supports some of the very best research. Six of our past and present faculty have been awarded the Nobel Prize in Economics. In the classroom, we bring the same rigorous, innovative approach to enable our students to develop their talents and realize the potential of their tremendous analytical skills.

At Carnegie Mellon University, the Undergraduate Economics Program is supported by both the Tepper School of Business and the College of Humanities and Social Sciences. Economics majors are considered members of both colleges and enjoy their full support and services.

Degree Options

In order to accommodate students' wide variety of goals, three primary degree programs are available: Bachelor of Arts in Economics, Bachelor of Science in Economics, and Bachelor of Science in Economics and Statistics (jointly administered by the Department of Statistics and the Undergraduate Economics Program).

For students who major in other academic fields, an additional major program and a minor degree program in Economics are available. This information can be found following the discussions about the major curricula and schedules.

The three degree programs have been designed to provide students with a solid understanding of the central theories and analytical tools of the field of economics, while maintaining the flexibility necessary to meet the needs of a diversity of career paths. The three degrees produce strong analytical thinkers who are able to model and analyze complex problems. Graduates of the Undergraduate Economics Program gain employment as economic analysts in both the private and public sectors; pursue advanced professional degrees in business, law, and public policy; as well as enter into Ph.D. programs in economics, statistics, finance, and related fields.

First-year students are not expected to know which degree option they wish to pursue. For this reason, the first-year curricula are identical. As students become involved in their course work, participate in the extra- and co-curricular activities sponsored by the Undergraduate Economics Program, and talk with an economics advisor, the decision of which degree to pursue becomes quite evident.

The B.A. in Economics Curriculum and **The B.S. in Economics Curriculum** are designed to provide students with a solid understanding of the economic theory and quantitative economic analysis. The introductory core disciplinary sequences in economic theory and quantitative analysis are identical: both rely on the same knowledge base of calculus and statistics. Where these two degree programs differ is in their emphases of study in the advanced levels. The advanced data analysis component of the **B.A. in Economics Curriculum** pays additional attention to ordinal data and the study of surveys. The flexibility of the "Special Electives" requirement allows students the opportunity to study political, historical, cultural, and social institutions. In the advanced levels

of the economic theory component of the **B.S. in Economics Curriculum**, the foundations of modern economics are examined, using mathematically sophisticated models. The capstone of this degree program is the Senior Project course where students use their qualitative and quantitative skills to contribute to the body of knowledge in empirical, experimental, and/or theoretical studies.

The B.S. in Economics and Statistics Curriculum is a collaborative effort between the Department of Statistics and the Undergraduate Economics Program. It provides an interdisciplinary course of study aimed at students with a strong interest in the empirical analysis of economic data. The major's curriculum provides students with a solid foundation in the theories and methods of both fields. Students in this major are trained to advance the understanding of economics issues through the analysis, synthesis, and reporting of data using the advanced empirical research methods of statistics and econometrics.

Dual Degree in Economics

A student pursuing a primary degree outside of the department may obtain a dual degree in economics by completing all of the requirements for a B.S. in Economics. In addition, the student's total units complete must be at least 90 units in excess of the requirement for the student's other degree(s) or at least 450 units, whichever is greater. Interested students should meet with an economics advisor.

Honors Programs

Outstanding students are eligible for the honors programs in both the Tepper School of Business and the College of Humanities and Social Sciences. The Senior Honors Programs in Economics provide qualified students with the opportunity to engage in original research during their senior year at Carnegie Mellon. Invited students demonstrate and further develop their skills in economic analysis and research through the completion of a senior honors thesis. For many, this process of intellectual inquiry and knowledge creation is the highlight and culmination of their undergraduate academic experience. In addition to submitting a Senior Honors Thesis, the students present their work at Carnegie Mellon's annual undergraduate research symposium *Meeting of the Minds*. Students who successfully complete the Honors Program graduate with "College Honors". For more details about the Tepper Seniors Honors Program in Economics, visit the "Curricula" section of the Undergraduate Economics Program website. For details about the H&SS Honors Program, visit the "Advising & Careers" section of the H&SS Website.

Accelerated Master's Degree Programs

Accelerated Master's Degree programs enable exceptional students to earn both an undergraduate degree and a masters degree by remaining one additional year at Carnegie Mellon. The Heinz School of Public Policy and Management offers two professional accelerated masters degree programs: a Master of Science in Public Policy and Management and a Master of Information Systems Management. The Tepper School of Business offers one accelerated professional degree, Master in Business Administration, and one accelerated academic degree, Master in Quantitative Economics. Interested students should consult with their economics advisor for further information. For more details about Accelerated Master's Degree Programs, visit the "Curricula" section of the Undergraduate Economics Program website.

Degree Requirements

In addition to completing at least 360 units, the H&SS General Education requirements, and University requirements, recipients of an undergraduate degree in economics must complete courses in mathematics, probability and statistics, writing, economics theory, and economic analysis, as well as a set of advanced electives and other specialized courses. For more information, please visit the

"Curriculum" section of the Undergraduate Economics Program's website. Specific requirements for the degrees are as follows:

B.A. in Economics Curriculum

Mathematics Prerequisites	19 Units
21-120 Differential and Integral Calculus	10
21-256 Multivariate Analysis and Approximation	9
Programming Requirement	10 Units
15-100 Introductory/Intermediate Programming	10
Writing Requirement	9 Units
<i>Choose one:</i>	
73-270 Professional Writing for Economists	9
76-270 Writing in the Professions	9
76-271 Introduction to Professional and Technical Writing	9
Economic Theory Requirements	27 Units
73-100 Principles of Economics	9
73-150 Microeconomics	9
73-200 Macroeconomics	9
Economic History Requirement	9 Units
73-310 History of Economic Issues and Analysis	9
Quantitative Analysis Requirements	45 Units
36-201 Statistical Reasoning and Practice	9
36-202 Statistical Methods	9
36-303 Sampling, Survey, and Society	9
36-310 Fundamentals of Statistical Modeling	9
73-261 Econometrics	9

Advanced Economics Electives 36 Units

Students must take four advanced elective courses. Advanced elective courses are those numbered 73-300 through 73-495, as well as courses designated by the Program offered by other departments/programs. Additionally, students may work with their advisor to structure alternative sets of courses to meet these requirements based on their particular interests, subject to course availability.

Special Electives 27 Units

Students must take three special elective courses in the humanities and social sciences. The list of courses designated as special electives is maintained and revised from time to time by the Undergraduate Economics Program.

B.S. in Economics Curriculum

Mathematics Requirements 29 Units

Complete all of the following:

21-120 Differential and Integral Calculus	10
21-122 Integration, Differential Equations and Approximation	10
21-259* Calculus in Three Dimensions	9

*21-256 (Multivariate Analysis and Approximation) can be substituted for 21-259.

Programming Requirement 10 Units

15-100 Introductory/Intermediate Programming	10
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Quantitative Analysis Requirements 45 Units

Choose one option:

Option 1:	
36-202 Statistical Methods	9
36-310 Fundamentals of Statistical Modeling	9
73-261 Econometrics	9
Option 2:	
36-225* Introduction to Probability and Statistics I	9
36-226 Introduction to Probability and Statistics II	9
73-261 Econometrics	9

*Acceptable equivalents for 36-225 are 21-325 and 36-217.

Writing Requirement 9 Units

Choose one:

73-270 Professional Writing for Economists	9
76-270 Writing in the Professions	9
76-271 Introduction to Professional and Technical Writing	9

Economic Theory Requirements 39 Units

Complete all of the following:

73-100 Principles of Economics	
73-150 Microeconomics	9
73-200 Macroeconomics	9
73-252 Advanced Microeconomic Theory	6
73-253 Advanced Macroeconomic Theory	6

Advanced Economics Electives 45 Units

Students must take five advanced elective courses, at least two of which have 73-252 or 73-253 as a prerequisite. Advanced elective courses are those numbered 73-300 through 73-495. For the purpose of these requirements, the Undergraduate Economics Program may also designate as advanced electives courses from other departments/programs. Additionally, students may work with their advisor to structure alternative sets of courses to meet these requirements based on their particular interests, subject to course availability.

Senior Project 9 Units

73-497 Senior Project	9
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B.S. in Economics and Statistics Curriculum

I. Prerequisites

Mathematics Foundations 38 Units

Complete all of the following:

21-120 Differential and Integral Calculus	10
21-122 Integration, Differential Equations, and Approximations	10
21-259* Calculus in Three Dimensions	9
21-241 Matrix Algebra	9

*21-256 (Multivariate Analysis and Approximation) can be substituted for 21-259.

Statistical Foundations 18 Units

Complete all of the following:

36-201* Introduction to Statistical Reasoning and Practice	9
and one of the following:	
36-202 Statistical Methods	9
36-208 Regression Analysis	9
36-309 Experimental Design for Behavioral and Social Sciences	9

* Acceptable equivalents for 36-201 are 36-207, 36-220, 36-247, and 70-207

Writing Requirement 9 Units

Choose one:

73-270 Writing for Economists	9
76-270 Writing in the Professions	9
76-271 Introduction to Professional and Technical Writing	9

II. Disciplinary Core

Economics Core 39 Units

73-100 Principles of Economics	9
73-150 Microeconomics	9
73-200 Macroeconomics	9
73-252 Advanced Microeconomic Theory	6
73-253 Advanced Macroeconomic Theory	6
73-261 Econometrics	9

Statistics Core 36 Units

36-225 Introduction to Probability and Statistics I	9
36-226 Introduction to Probability and Statistics II	9
36-401 Modern Regression	9
36-402 Advanced Data Analysis (Project Course)	9

Economic Electives 18 Units

Students must take two advanced economic elective courses. Advanced elective courses are those courses numbered 73-300 through 73-495.

Statistics Electives 18 Units

Students must take two courses at the 36-300 level or above.

Additional Major in Economics Curriculum

The requirements for an additional major in Economics are the same as those for the B.S. in Economics, except that the H&SS general education requirements are waived. In order to avoid "double counting" issues, students are encouraged to meet with an economics advisor.

Minor in Economics

The requirements for a minor in Economics consist of mathematics requirements, probability and statistics requirements, and economics courses listed below. In order to avoid "double counting" issues, students are encouraged to meet with an economics advisor.

Mathematics Requirements 19 Units

21-120	Differential and Integral Calculus	10
<i>Choose one:</i>		
21-256	Multivariate Analysis and Approximation	9
21-259	Calculus in Three Dimensions	9

Economic Theory Requirements 27 Units

Complete all of the following:

73-100	Principles of Economics	9
73-150	Microeconomics	9
73-200	Macroeconomics	9

Quantitative Analysis Requirements 27 Units

Choose one option:

Option 1:

36-202	Statistical Methods	9
36-310	Fundamentals of Statistical Modeling	9
73-261	Econometrics	9

^a Acceptable equivalents for 36-201 are 36-207, 36-330, 36-247, and 70-207.

Option 2:

36-225 ^b	Introduction to Probability and Statistics I	9
36-226	Introduction to Probability and Statistics II	9
73-261	Econometrics	9

^b Acceptable equivalents for 36-225 are 21-325 and 36-217.

Advanced Economics Electives 18 Units

Students must take two advanced elective courses. Advanced elective courses are those numbered 73-300 through 73-495, as well as courses designated by the program offered by other departments/programs. Additionally, students may work with their advisor to structure alternative sets of courses to meet these requirements based on their particular interests, subject to course availability.

Sample Course Schedules

What follows are sample four-year course schedules for a student pursuing undergraduate degrees in Economics. As there are many different ways of completing the requirements, students are strongly encouraged to meet with an economics advisor to tailor their courses to their own particular needs. It is the responsibilities of the students to ensure that they understand all of the program requirements and that they meet the necessary conditions for graduation. When planning course schedules, students must give consideration to all prerequisite and corequisite requirements. Course descriptions, prerequisites, and corequisites can be found at the back of this catalog.

Sample Schedule for B.A. in Economics**First Year**

Fall		49 Units
21-120	Differential and Integral Calculus	10
36-201	Statistical Reasoning	9
73-100	Principles of Economics	9
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
xx-xxx	Freshman Seminar	9
Spring		46 Units
15-100	Introductory/Intermediate Programming	10
21-259	Calculus in Three Dimensions	9
36-202	Statistical Methods	9
73-150	Microeconomics	9
79-104	World History	9

Second Year

Fall		45 Units
36-310	Fundamentals of Statistical Modeling	9
73-200	Macroeconomics	9
xx-xxx	"Special" elective	9
xx-xxx	elective	9
xx-xxx	elective	9
Spring		45 Units
36-303	Sampling, Survey and Society	9
73-270	Writing for Economists	9
73-310	History of Economic Issues and Analysis	9
xx-xxx	elective	9
xx-xxx	elective	9

Third Year

Fall		45 Units
73-261	Econometrics	9
xx-xxx	Advanced Economics Elective	9
xx-xxx	"Special" elective	9
xx-xxx	Advanced Economics Elective	9
xx-xxx	elective	9
Spring		45 Units
xx-xxx	Advanced Economics Elective	9
xx-xxx	"Special" Elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9

Fourth Year

Fall		45 Units
xx-xxx	Advanced Economics Elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9
Spring		45 Units
xx-xxx	Advanced Economics Elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9

Sample Schedule for B.S. in Economics

First Year		
	Fall	49 Units
21-120	Differential and Integral Calculus	10
36-201	Statistical Reasoning	9
73-100	Principles of Economics	9
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
xx-xxx	Freshman Seminar	9
	Spring	46 Units
15-100	Introductory/Intermediate Programming	10
21-259	Calculus in Three Dimensions	9
36-202	Statistical Methods	9
73-150	Microeconomics	9
79-104	World History	9
Second Year		
	Fall	46 Units
21-122	Integration, Differential Equations and Approximation	10
73-200	Macroeconomics	9
36-310	Fundamentals of Statistical Modeling	9
xx-xxx	elective	9
xx-xxx	elective	9
	Spring	48 Units
73-252/3	Advanced Economic Theory ^c	12
73-270	Writing for Economists	9
xx-xxx	Advanced Economics Elective	9
xx-xxx	elective	9
xx-xxx	elective	9

^c A semester-long sequence consisting of two mini-courses, 73-252 Advanced Microeconomic Theory and 73-253 Advanced Macroeconomic Theory.

Third Year		
	Fall	45 Units
73-261	Econometrics	9
xx-xxx	Advanced Economics Elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9
	Spring	45 Units
xx-xxx	Advanced Economics Elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9
Fourth Year		
	Fall	45 Units
79-497	Senior Project	9
xx-xxx	Advanced Economics Elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9
	Spring	45 Units
xx-xxx	Advanced Economics Elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9

Sample Schedule for B.S. in Economics and Statistics

Year	Fall	Spring
Freshman	21-120 36-201 ----- ** ----- -----	21-122 36-202 73-150 ----- -----
Sophomore	21-256 36-225 73-200 ----- -----	21-241 36-226 73-252/3 ----- -----
Junior*	36-401 73-261 Writing Req. Econ Elective -----	36-402 Stats Elective ----- ----- -----
Senior	Stats Elective ----- ----- -----	Econ Elective ----- ----- -----

* A student could spend, for example, year 3 abroad and move year 3 courses to year 4.

** In each semester, ----- represents other courses (not related to the major) which are needed in order to complete the 360 units that the degree requires.

Faculty

LAURENCE ALES, Assistant Professor of Economics — Ph.D., University of Minnesota; Carnegie Mellon, 2008—.

STEPHEN M. CALABRESE, Associate Professor of Economics — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2005—.

KAREN B. CLAY, Associate Professor of Economics and Public Policy — Ph.D., Stanford University; Carnegie Mellon, 1998—.

DANIELLE COEN PIRANI, Associate Professor of Economics — Ph.D., University of Rochester; Carnegie Mellon, 2000—.

ROBERT M. DAMMON, Professor of Financial Economics and Associate Dean, Education — Ph.D., University of Wisconsin; Carnegie Mellon, 1984—;

JUAN M. DUBRA, Visiting Associate Professor of Economics — Ph. D., New York University; Carnegie Mellon (Spring Only), 2006—.

KENNETH B. DUNN, Professor of Financial Economics and Dean — Ph.D., Purdue University; Carnegie Mellon, 2003—;

DENNIS N. EPPLER, Thomas Lord Professor of Economics; Head, Economics Programs — Ph.D., Princeton University; Carnegie Mellon, 1974—.

MARIA FERREYRA, Assistant Professor of Economics — Ph.D., University of Wisconsin; Carnegie Mellon, 2002—.

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DAVID L. FULLER, Visiting Assistant Professor of Economics — Ph.D., University of Iowa; Carnegie Mellon, 2008—.

GEORGE-LEVI GAYLE, Assistant Professor of Economics — Ph.D., University of Pittsburgh; Carnegie Mellon, 2003—.

MARTIN GAYNOR, E.J. Barone Professor of Economics and Health Policy — Ph.D., Northwestern University; Carnegie Mellon, 1995—.

LIMOR GOLAN, Assistant Professor of Economics — Ph.D., University of Wisconsin-Madison; Carnegie Mellon, 2002—.

CAROL B. GOLDBURG, Adjunct Professor of Economics and Director, Undergraduate Economics Program — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2005—.

MARVIN GOODFRIEND, Professor of Economics and President, Gailliot Center for Public Policy, Ph.D., Brown University, Carnegie Mellon, 2005 —.

RICHARD C. GREEN, Richard M. and Margaret S. Cyert Professor of Economics and Management and Associate Dean, Research- Ph.D., University of Wisconsin; Carnegie Mellon, 1982 —.

ELIF INCEKARA HAFALIR, Visiting Assistant Professor of Economics — Ph.D., Penn State University; Carnegie Mellon, 2007—.

ISA E. HAFALIR, Assistant Professor of Economics — Ph.D., Penn State University; Carnegie Mellon, 2007—.

BURTON HOLLIFIELD, Professor of Financial Economics — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1999—.

CHRISTIAN JULLIARD, Visiting Assistant Professor of Economics — Ph.D., Princeton University; Carnegie Mellon, 2008—.

ONUR KESTEN, Assistant Professor of Economics — Ph.D., University of Rochester; Carnegie Mellon, 2005 —.

STEVEN KLEPPER, Arthur Arton Hamerschlag Professor of Economics and Social Science — Ph.D., Cornell University; Carnegie Mellon, 1980—.

YAROSLAV KRYUKOV, Visiting Assistant Professor of Economics — Ph.D., Northwestern University; Carnegie Mellon, 2008—.

FINN KYDLAND, Professor of Economics — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1977—.

LESTER B. LAVE, Harry B. and James H. Higgins Professor of Economics and University Professor; Director, Carnegie Mellon Green Design Initiative; Co-Director, Carnegie Mellon Electricity Industry Center — Ph.D., Harvard University; Carnegie Mellon, 1963—.

BENNETT T. MCCALLUM, H. J. Heinz Professor of Economics — Ph.D., Rice University; Carnegie Mellon, 1981—.

ALLAN H. MELTZER, The Allan H. Meltzer University Professor of Political Economy — Ph.D., University of California, Los Angeles; Carnegie Mellon, 1957—.

ROBERT A. MILLER, Professor of Economics and Strategy — Ph.D., University of Chicago; Carnegie Mellon, 1982—.

JOHN R. O'BRIEN, Associate Professor of Accounting and Experimental Economics — Ph.D., University of Minnesota; Carnegie Mellon, 1984—.

FREDERICK H. RUETER, Adjunct Professor of Economics — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1988—.

DUANE J. SEPPI, Professor of Financial Economics — Ph.D., University of Chicago; Carnegie Mellon, 1986—.

HOLGER SIEG, Professor of Economics— Ph.D., Carnegie Mellon University; Carnegie Mellon, 2001—.

PATRICK W. SILEO, Adjunct Professor of Economics — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2000—.

CHRISTOPHER SLEET, Associate Professor of Economics - Ph.D., Stanford University; Carnegie Mellon, 2005—.

CHESTER S. SPATT, Mellon Bank Professor of Finance; Director, Center for Financial Markets — Ph.D., University of Pennsylvania; Carnegie Mellon, 1979—.

FALLAW B. SOWELL, Associate Professor of Economics — Ph.D., Duke University; Carnegie Mellon, 1988—.

STEPHEN E. SPEAR, Professor of Economics — Ph.D., University of Pennsylvania; Carnegie Mellon, 1982—.

CHRIS I. TELMER, Associate Professor of Financial Economics — Ph.D., Queen's University (Canada); Carnegie Mellon, 1992—.

ROBERTO WEBER, Associate Professor of Economics and Social and Decision Sciences — Ph.D., California Institute of Technology; Carnegie Mellon, 2000—.

SEVIN YELTEKIN, Associate Professor of Economics — Ph.D., Stanford University; Carnegie Mellon, 2005—.

STANLEY E. ZIN, The Richard M. Cyert and Morris H. DeGroot Professor of Economics and Statistics; Professor of Economics and Finance, — Ph.D., University of Toronto; Carnegie Mellon, 1988—.

Department of English

David Kaufer, Department Head
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The Department of English at Carnegie Mellon involves students in the important study of reading and writing as they are embedded in historical, cultural, professional, technological, and literary practices. Working with faculty who are themselves writers, scholars, and researchers in these areas, students become effective writers and analysts of various kinds of texts in a range of media. We hold strongly to our traditional interest in print documents but extend the idea of text to include other media such as film, multimedia, and on-line texts. The types of texts that students and faculty work with include academic writing, criticism, fiction and nonfiction, professional and technical writing, argument and public advocacy, poetry, film, and even screenwriting. The English Department faculty have particular strengths in Creative Writing, in Literary and Cultural Studies, and in Rhetoric. Specialists in each area use distinctive methods of studying texts, but all share a deep commitment to working in small and intense workshops and seminars to help students learn to become experts in analyzing existing texts, and in producing original and distinctive work of their own.

The English Department offers a B.A. in English, a B.A. in Creative Writing, a B.A. in Professional Writing, and a B.S. in Technical Writing and Communication. All four majors involve the relationship of texts to contexts, and all four are structured to allow students to balance liberal and professional interests. Students in the English B.A. focus on the production and interpretation of print texts and other media in their social and cultural contexts. Students in the Creative Writing B.A. focus on analyzing and learning to produce poetic and narrative forms. Students in the Professional Writing B.A. focus on analyzing and producing non-fiction for a variety of professional contexts. Students in the Technical Writing B.S. focus on integrating writing with technical expertise in a chosen area of concentration. In addition to the four majors, the department offers a minor in English and strongly encourages non-majors in the campus community to join us in English courses, beginning with offerings at the 200-level.

English faculty and students represent a diverse but close community with a shared interest in understanding how texts are produced and understood. This interest is the foundation for the formal curriculum and also the inspiration for a range of complementary activities, including a reading series of distinguished writers of fiction and non-fiction. English majors also have multiple opportunities to gain experience in publishing, editing, and marketing through involvement with The Oakland Review and The Carnegie Mellon University Press. Many of our students hold writing and editorial positions on the student newspaper, The Tartan, and other campus publications. We also offer a strong internship program that places student writers in media, non-profit, arts, corporate, and technical internships before they graduate. The end of every year culminates in a gala event to celebrate our students and their writing achievements in literary, academic, and professional writing. For this event, known as the Pauline Adamson Awards, we invite a well-known writer to do a public reading and then present and celebrate student writing awards in over a dozen categories, all judged anonymously by writing professionals from outside the university. Nationally prominent speakers who have participated in this event include Michael Cunningham, Jamaica Kincaid, Michael Ondaatje, Tobias Wolfe, Stanley Kunitz and Dennis Lehane.

Undergraduate students also have the opportunity to apply to the various Masters level graduate programs sponsored by the department. Students interested in communications careers in both the public and private sectors may receive advanced training in our Masters in Professional Writing (MAPW) program. Students who have interests in visual as well as verbal communication apply to the Masters in Design in Communication Planning and Information Design (jointly administered with the School of Design). Students with academic interests looking toward doctoral work can apply to our Masters programs in Rhetoric and in Literary and Cultural Studies to acquaint themselves with and to prepare for academic careers. The best of our Masters candidates may request consideration for the department's Ph.D. programs in Rhetoric or in Literary and Cultural Studies and will be, in any case, well prepared for graduate work no matter where they chose to go. Upper level

undergraduates interested in graduate level work should contact the English Department directly for further information and for advice on planning their junior and senior years to prepare for graduate study.

Majoring in English:

The Four English Degree Options

All students who major in English choose one of the four majors offered by the department as the main focus of their studies:

The B.A. in English
 The B.A. in Creative Writing
 The B.A. in Professional Writing
 The B.S. in Technical Writing & Communication

Other Options for English Majors

Students who wish to broaden their experience with English courses may do so by taking more than the minimum requirements for each major or by combining two of the majors within the department for a double major in English. Common combinations include Professional Writing and Creative Writing, Creative Writing and the B.A. in English, or the B.A. in English and Professional Writing. Students who are already majoring in one of the English degrees can generally add a second English major by completing 5 to 7 additional courses. Consult the English Department and the section below on "Completing an Additional Major in English" for further detail.

All of the English majors may also be combined with majors and minors from other Carnegie Mellon departments and colleges. English Department advisors can help you to explore the available options and to choose a major or combination of programs that is appropriate for your interests and goals.

How the Curriculum is Structured

In addition to H&SS requirements, English majors complete 11 to 12 courses (99 to 114 units) specifically related to their chosen major within English and structured as indicated below. Please note that courses taken to fulfill requirements in other major or minor programs may not be applied to requirements for any of the English Department majors or minors.

English Department Core: 1–2 courses, 9–18 units

76-26x Survey of Forms (Creative NonFiction, Fiction, Poetry, or Screenwriting)

76-294 Interpretive Practices (required for B.A. in English only)

The English Department Core is designed to introduce students to various genres of writing, to the fundamental concepts and techniques of fiction and non-fiction, and to a conceptual understanding of how texts are produced and interpreted. In the Survey of Forms courses, students learn how to use language to express experience through poetic and narrative forms. In Interpretive Practices, students are introduced to basic concepts, methods, and practices of literary and rhetorical approaches to texts and their social and cultural contexts.

Core Requirements for the Specific Major:

5 to 7 courses, 45 to 63 units

Complete five to seven courses.

The Core Requirements differ for each major and are designed explicitly to provide both breadth and depth within the specific major the student has chosen.

English Electives:

3 to 4 courses, 27 to 36 units

Complete three to four elective courses.

Elective Courses for the major are designed to add breadth to each student's study within English and to provide experience with the range of approaches to reading and writing available within the department. Students in all English majors are encouraged to sample widely from the Department's offerings.

The B.A. in English

An important role of English departments has been to create interpretations of the literature of various historical periods, including the present. The B.A. in English (EBA) at Carnegie Mellon builds on, and also extends, this tradition by teaching texts as part of a complex web of historical conditions and relationships; by teaching both major literary texts and public and non-fiction documents; and by teaching film, television, and other storytelling media alongside more conventional texts.

The B.A. in English is distinctive in drawing from the artistic and research strengths of the Department's faculty in Literary and Cultural Studies, Rhetoric, and Creative Writing. Literary and Cultural Studies focuses on the way texts are formally constructed and how they function in historical and contemporary contexts. Creative Writing helps students focus on language as a tool to explore and depict experience. Rhetoric focuses on the principles through which writers construct texts and audiences respond to them. Drawing from all of these perspectives, students in the B.A. in English learn the research skills and writing strategies to enable them to analyze the language and texts of other writers and to report their research in effective texts of their own. Such training can prepare students for graduate work in literature, cultural studies, or rhetoric, and also for careers in law, business, or government, which require similar skills in interpretation, research, and writing.

The 200-level core courses are designed to introduce students to writing in a variety of genres, to a knowledge of literary and other media forms, and to a basic theoretical knowledge of how texts are produced and interpreted. In the Interpretive Practices course, students are introduced to basic concepts, methods, and practices of literary and rhetorical approaches to texts. In the Survey of Forms course, students learn how to use language to express experience through poetic and narrative forms.

Beyond these English Department core courses, students take at least one course in rhetoric, two 300-level EBA core courses, and two 400-level seminars designed to introduce them to the functioning of texts within specific cultural and rhetorical contexts. Two of 300- and 400-level courses must feature a specific historical period, and one of these "period" courses must have a pre-1900 focus. Period study introduces students to a range of historical and cultural texts and to a range of methods for analyzing these texts in their original context and across contexts. Courses that fulfill the Rhetoric Requirement focus explicitly on language and discourse as objects of study and emphasize the relationships of language, text structure, and meaning within specific contexts.

Research in English Studies (76-394) is also required of students in the B.A. in English. This course offers training in gathering information systematically and in building arguments based on that information. Students will hone their skills in reading texts, using critical commentary, assessing print and electronic materials, and conducting interviews and surveys. They will learn how to test their hypotheses against alternatives and present their research to audiences within the discipline of English. The historical or thematic content of this course will vary from one semester to another. While 76-394 is not a pre-requisite for 400 level courses, it is strongly recommended that EBA majors take this course in their Junior year. At the advanced level EBA majors are required to take two 400-level seminars for which 76-294 is a pre-requisite.

EBA majors also complete three English Electives, one at the 200 or above level and two at the 300 or 400 level. Electives at the 200 level allow students to sample introductory courses in special topics – such as gender and media studies – within rhetorical, literary, and cultural studies, or genre courses in the novel or comedy. Electives at the 300 and 400 level encourage students to explore more advanced study in the various offerings within the department. In choosing their electives, EBA students are encouraged to sample courses from across the department.

Curriculum

In addition to satisfying all of the H&SS degree requirements for B.A. candidates, English B.A. majors must complete 11 courses in the following areas:

English Department Core:

2 courses, 18 units

Complete both courses:

76-26x	Survey of Forms (Creative Nonfiction, Fiction, Poetry, or Screenwriting)
76-294	Interpretive Practices

EBA Core Requirements: 6 courses, 54 units

Complete six required courses.

Research Course

76-394	Research in English Studies
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Rhetoric Requirement

Complete one course from a set of varied offerings in Rhetoric as designated each term by the English Department. Rhetoric courses focus explicitly on language and discourse as objects of study and emphasize the relationships of language, text structure, and meaning within specific contexts.

Two 300-level Courses

Complete two 300-level courses that investigate the production and interpretation of texts and other media from a variety of periods and theoretical and methodological perspectives. Course offerings that meet these requirements are advertised on a semester-by-semester basis. For EBA majors, 76-294: Interpretive Practices is a prerequisite for these courses. Course options include but are not limited to the following:

76-330	Medieval Literary and Cultural Studies
76-331	Renaissance Literary and Cultural Studies
76-332	African American Studies
76-335	20th Century Literary and Cultural Studies
76-339	Advanced Studies in Media
76-347	American Literary & Cultural Studies
76-353	Advanced Gender Studies
76-386	Language and Culture
76-387	Sociolinguistics
76-393	Rhetorical Traditions
76-492	Rhetoric and Public Policy

"Period" Course Requirement

The period course requirement is not a separate course requirement per se but one that needs to be met through the selection of the required 300- and 400-level courses. At least two of these four required courses must be "period" courses, that is, courses that focus on texts that are connected in time and place or through common social concerns. One of these two courses must focus on a historical period prior to 1900. Courses in this category will vary from year to year and be advertised on a semester-by-semester basis. Such courses may be at either the 300 or 400 level.

Two 400-level Seminar Courses

Complete two 400-level seminar courses which investigate a specific topic in depth and allow students to work on a major research-based paper. Courses in this category will be advertised on a semester-by-semester basis. For EBA majors, 76-294: Interpretive Practices is a prerequisite and 76-394: Research in English Studies is pre- or co-requisite. Among current course offerings, examples include but are not limited to the following:

76-431	Advanced Seminar in British Literary and Cultural Studies
76-433	Postcolonial Literature and Theory
76-441	Chaucer
76-444	Enlightenment Sexualities
76-439	Advanced Seminar in Film Studies
76-451	Topics in Language Studies
76-457	Topics in Rhetorical Study
76-476	Rhetoric of Science
76-482	Comparative Rhetoric

English Electives

3 courses, 27 units

Complete three courses from the English Department's offerings. One may be at the 200 level or above; the remaining two must be at the 300 or 400 level. Electives may include any courses offered by the English Department with the exception of 76-201, 76-205, and 76-206, all of which are designed for non-majors. Some semester offerings may include cross-listed courses from Modern Languages or History.

English B.A.

Sample Curriculum

This plan is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years not that it should or must be. In fact, as a department, we recommend beginning the major in the sophomore year if possible. Students in H&SS may declare a major as early as mid-semester of the spring of their first year and begin major requirements the following fall. 76-294 Interpretive Practices should generally be taken in the sophomore year and before 76-394.

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Survey of Forms 76-26x	300-level EBA course* 76-3xx	400-level Seminar** 76-4xx	400-level Seminar** 76-4xx
Interpretive Practices 76-294	Rhetoric Course 76-3xx/4xx	300-level EBA course* 76-3xx	English Elective 76-3xx/4xx
Research in English Studies 76-394	English Elective 76-2xx-3xx	English Elective 76-3xx/4xx	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

* 76-294 is a prerequisite for 300-level EBA courses

** 76-294 is a prerequisite and 76-394 is a pre- or co-requisite for 400-level seminars.

The B.A. in Creative Writing

Carnegie Mellon is one of a small number of English departments in the country where undergraduates can major in Creative Writing. In the Creative Writing major (CW), students develop their talents in writing fiction, poetry, and other imaginative forms. While studying with faculty members who are practicing poets and prose writers, Creative Writing majors read widely in literature, explore the resources of their imaginations, sharpen their critical and verbal skills, and develop a professional attitude toward their writing. Students also have the opportunity to work with other nationally known poets and fiction writers through the department's Visiting Writers series. The CW program, based on a conservatory model, is made up of faculty and students who have an intense commitment to their work. Students who do not exhibit a high level of commitment and promise in the introductory classes will not be encouraged to continue in the major.

Beginning with the H&SS requirements, the curriculum for Creative Writing majors is designed to broaden the students' intellectual backgrounds and encourage their analytical abilities. English courses beyond the Creative Writing core requirements provide additional practice in the careful reading, writing and understanding of literary texts.

Students in the Creative Writing major are required to take two of the introductory Survey of Forms courses, ideally in their sophomore year. Choices include Poetry (76-265), Fiction (76-260), Screenwriting (76-269), and Nonfiction (76-261). In order to proceed into the upper level courses in the major (and in each of the genres), students must do well in these introductory courses (receive a grade of A or B). In their junior and senior years, Creative Writing majors take four workshops in fiction, poetry, screenwriting, or nonfiction. At least two of the workshops must be taken in a single genre. In the writing workshops, students develop their critical and verbal abilities through close writing and analysis of poems, stories, and other literary forms. Their work is critiqued and

evaluated by peers and the faculty. Students may write a Senior Project or Honors Thesis under the supervision of a faculty member during their senior year.

Carnegie Mellon also offers Creative Writing majors various extracurricular opportunities for professional development. For example, they may work as interns with the Carnegie Mellon University Press, which is housed in the English Department. The Press publishes scholarly works, and books of poetry and short stories by both new and established American writers. Students may help edit and submit their work for publication to *The Oakland Review*, a Carnegie Mellon University-sponsored annual journal, and *Dossier*, the literary supplement to *The Tartan* (the student newspaper). Students also have opportunities to read their works in a series of readings by student writers held in the Gladys Schmitt Creative Writing Center and to hear nationally known authors as part of the Carnegie Mellon Visiting Writers series. Additionally, the English Department (in cooperation with the Carnegie Mellon University Press) offers prizes for students each year in the writing of fiction, non-fiction, poetry and screenwriting. These include the Pauline Adamson Awards, the Academy of American Poets Prize, the Carnegie Mellon University Press Prizes in poetry and fiction, the Hilary Masters Award in Personal Essay, the Family Friendly Programming Forum Scholarships in Film, and the Topol Award in Creative Writing/Fiction. In addition, the Gladys Schmitt Scholarship Fund and the Gladys Schmitt Student Enhancement Fund provide support for creative writing majors to attend writing conferences and festivals.

Because the Creative Writing program provides a disciplined atmosphere in which to study and write, it appeals especially to students who are as concerned with their personal growth as with vocational goals. Nevertheless, the extracurricular writing activities and a variety of writing internships available on and off campus can provide Creative Writing majors with valuable experiences for planning their future. After graduation, most Creative Writing majors have gone on to graduate writing programs and to careers in teaching, publishing, public relations, advertising, TV and film, or freelance writing and editing.

Curriculum

In addition to satisfying all of the H&SS degree requirements for B.A. candidates, Creative Writing majors must complete 11 courses in the following areas:

English Department Core:

1 course, 9 units

76-26x Survey of Forms (Creative Nonfiction, Fiction, Poetry, or Screenwriting)*

* A student must receive a grade of A or B in the Survey of Forms class in a specific genre in order to be eligible to enroll in a workshop of that genre. A student who receives a grade of C in a Survey of Forms course may enroll in a related workshop only with the permission of the workshop professor. A student who receives a D or R in Survey of Forms may not take a workshop in that genre.

Creative Writing Core:

6 courses, 54 units

A Second Survey of Forms Course *

Complete one of the following courses in addition to the 76-26x course completed for the English Department Core requirement.

76-260 Survey of Forms: Fiction
76-261 Survey of Forms: Creative Nonfiction
76-265 Survey of Forms: Poetry
76-269 Survey of Forms: Screenwriting

One Reading in Forms Course

Complete one of the following courses:

76-328 Reading in Forms: New Journalism
76-362 Reading in Forms: Creative Nonfiction
76-363 Reading in Forms: Poetry
76-364 Reading in Forms: Fiction

Four Creative Writing Workshops

Complete four Creative Writing workshops, at least two in a single genre. Workshops in all genres may be taken more than once for credit.

76-365 Beginning Poetry Workshop
76-460 Beginning Fiction Workshop

76-461	Personal Essay
76-462	Advanced Fiction Workshop
76-465	Advanced Poetry Workshop
76-469	Screenwriting Workshop
76-4xx	Elective Workshops (various forms)

English Electives:

4 courses, 36 units

Complete four additional courses from the English Department's offerings. Two of the four English Electives must be courses that are designated as fulfilling the literature requirement and focus on close reading of literary texts. Please consult the list of courses published each semester by the Department for current offerings. English Electives may include any course offered by the Department with the exception of 76-201, 76-205, and 76-206, which are designed primarily for non-majors. Additionally, English Electives can include no more than one course at the 200 level. The remaining English Electives must be at the 300 or 400 level. In choosing Electives, students are encouraged to sample courses from across the Department.

Creative Writing B.A.

Sample Curriculum

This plan is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years not that it should or must be. In fact, as a department, we recommend beginning the major in the sophomore year if possible. Students in H&SS may declare a major as early as mid-semester of the spring of their first year and begin major requirements the following fall.

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Survey of Forms 76-26x	Survey of Forms 76-26x	Creative Writing Workshop 76-3xx/4xx	Creative Writing Workshop 76-3xx/4xx
Reading in Forms 76-3xx	Creative Writing Workshop 76-3xx/4xx	Creative Writing Workshop 76-3xx/4xx	English Elective 76-3xx/4xx
English Elective 76-3xx/4xx	English Elective 76-2xx-3xx	English Elective 76-3xx/4xx	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

The B.A. in Professional Writing

Professional Writing combines liberal and professional education with a strong foundation in rhetorical studies. While based firmly in the liberal arts tradition, the major has a strong career orientation and is specifically designed to prepare students for successful careers as writers and communications specialists in a range of fields: publishing, government, journalism, law, community advocacy, the non-profit sector, education, corporate communications, and the arts. The major is designed to develop articulate and reflective writing professionals with both the professional skills needed to negotiate current work contexts (including writing for the web and for multimedia) and the analytic and problem-solving skills needed to understand and keep pace with cultural and technological change.

Professional Writing majors take the English Department Core and then a cluster of advanced rhetoric, language studies, and writing courses designed to integrate theory with practice. Through special topics courses—journalism, on-line information design, advocacy writing, document design, science writing, corporate communications, writing for multimedia—students have the opportunity to study with faculty who are experts and practicing professionals in these fields. They also gain experience in working on client-based projects and develop a portfolio of polished writing samples that they can use in applying for internships and employment. Through courses in Rhetoric, Creative Writing, and Literary and Cultural Studies, students gain additional practice in the careful reading, writing, and analysis of literary and non-

fictional texts and important insights into how texts function in their historical and contemporary contexts.

While the major appeals to students with strong professional interests, elective requirements encourage writers to develop the broad intellectual background one expects from a university education. In choosing their elective courses beyond Department requirements, Professional Writing majors are encouraged to explore courses from across the university, keeping in mind the very important point that to be effective, writers must have both strong writing skills and in-depth knowledge of their subjects. While there is no formal requirement for these elective courses, students are encouraged to think about what courses will complement their interest in Professional Writing. Students interested in journalism, for example, are encouraged to take courses in history and political science, while those interested in writing for health-related fields are pointed toward courses in biology, chemistry, and healthcare policy. Other possible elective areas include business, organizational behavior, graphic design, the arts, psychology, economics, modern languages, and computer programming. Because the major in Professional Writing is deliberately structured to allow a broad range of options, majors in Professional Writing should consult closely with their English Department advisors on choosing both elective and required courses and in planning for internships and summer employment.

Various opportunities for writers to gain professional experience and accumulate material for their writing portfolios are available through campus publications, department-sponsored internships for academic credit, and writing-related employment on and off campus. Professional Writing majors frequently write for *The Tartan*, the student-run campus weekly newspaper, and have served as editor-in-chief, section editors, and reporters. Students serve similar functions on *The Carnegie Pulse*, Carnegie Mellon's first exclusively online student-run news source, founded by majors in the English Department in February 2004. Majors can also serve on the editorial staff of *The Oakland Review*, a Carnegie Mellon journal that publishes work by undergraduate writers from across the US and *The Triple Helix*, an international undergraduate journal of science, society, and law, which has an active chapter on the Carnegie Mellon campus. These publications provide opportunities for students to publish their own written work and to gain experience in skills ranging from editing, to layout, to production, to selling ads or managing business affairs. Students can also write for the faculty and staff newspaper, *Focus*, under the guidance of the editor, or take a course in editing and publishing with the Carnegie Mellon University Press. Additionally, the English Department offers student awards in Professional Writing each year. The awards are judged by professionals outside the university and include the Pauline Adamson Awards in non-fiction, The Alan and Gloria Siegel Awards in Professional Writing, and the Dawe Memorial Award to encourage creativity and innovation in publishing. The Dawe Award provides a junior in the department with a \$2000 grant to plan, produce, and publish an innovative magazine, newspaper, or other periodical publication.

Professional Writing majors have the option of taking writing internships for academic credit during their junior or senior year and are also strongly encouraged to seek professional internships during the summer. Opportunities in advertising, newspaper and magazine writing, medical communication, publishing, technical writing, public service organizations, web design, and public relations illustrate both internship possibilities and the kinds of employment that Professional Writing majors have taken after graduation. In addition to providing professional experience, these internships help students establish contacts outside the University and add professional publications to their portfolios. Recent academic year and summer internships have included organizations such as Magnet Communications, Women & Girls' Foundation of SW PA, Pittsburghlive.com, JFK Center for the Performing Arts, Software Engineering Institute Communications, WPLJ Radio, Sinuate Media, The Pittsburgh Mediation Center, WQED Magazine, KDKA Television, WPXI Television, Pittsburgh Children's Museum, Pittsburgh Post Gazette, Creative Non-Fiction (a professional journal), the Heinz Family Foundation, the Silver Eye Photography Studio, and Bayer Polymers.

Seniors also have the opportunity to complete a Senior Project or Honors Thesis in Rhetoric or Professional Writing under the direction of a faculty member. Ideas and guidance for choosing internships, courses, summer employment, and possible career paths are provided through a 3-unit course, 76-300 Professional Seminar, which meets once a week during the fall term and provides majors with the opportunity to meet and network with practicing professionals in a range of communications fields.

Curriculum

In addition to satisfying all of the H&SS degree requirements for B.A. candidates, Professional Writing majors must fulfill 12 requirements in the following areas:

Professional Writing Core:

9 courses, 81 units
Complete nine courses.

Foundations Courses

76-26x	Survey of Forms (Creative Nonfiction, Fiction, Poetry, or Screenwriting)
76-271	Introduction to Professional & Technical Writing
76-373	Argument
76-390	Style

Rhetoric/Language Studies Requirement

Complete one course from designated Rhetoric courses offered and advertised each semester by the Department. Rhetoric courses study language and the varied and specific ways it is used in both everyday and professional contexts. These courses emphasize the relationships among specific language purposes, text structure, and meaning within a variety of specific contexts and provide explicit techniques for analyzing and understanding language use that are extremely useful to all writers.

Four Advanced Writing/Rhetoric Courses

Complete four courses at the 300- or 400-level. Options for these courses include but are not limited to the following list. Additional courses that fulfill these requirements are advertised on a semester-by-semester basis. For help in choosing which of the possible options is most appropriate for various professional options – journalism, writing for new media, editing and publishing, public relations/corporate communications, or technical writing – consult your English Department advisor and the “Options for PW Majors” advising sheet available through the English Department.

76-318	Communicating in the Global Marketplace *
76-319	Environmental Rhetoric
76-357	Language, Power & the Law *
76-372	Introduction to Journalism
76-375	Magazine Writing *
76-378	Literacy: Educational Theory & Community Practice
76-385	Introduction to Discourse Analysis
76-386	Language and Culture
76-387	Sociolinguistics
76-389	Grammar of Standard Written English
76-391	Document Design *
76-395	Science Writing *
76-396	Writing, Advocacy, and Public Policy*
76-397	Instructional Text Design *
76-420	Processes of Reading and Writing
76-451	Topics in Language Study
76-452	Topics in Rhetorical Study
76-460	Literary Journalism *
76-472	Advanced Journalism *
76-476	Rhetoric of Science
76-479	Marketing, PR & Corporate Communications *
76-481	Writing for Multimedia *
76-485	New Public Sphere
76-487	On-line Information Design + 76-488 On-line Information Design Lab *
76-491	Software Documentation
76-492	Rhetoric and Public Policy
76-494	Healthcare Communications *
39-605/6	Product Design

* Courses that have prerequisites. Check course descriptions for specific details.

English Electives: 3 courses, 27 units

Complete three additional courses from the English Department's offerings. Two of the three Electives must be courses that focus on the relationships between texts and their cultural and historical contexts. Courses in literature, cultural studies, and rhetoric that meet this requirement are advertised on a semester-by-semester basis. Please consult the list of courses published each semester by the Department for current offerings in this category. English Electives may include any course offered by the Department with

the exception of 76-270, and 76-272, all of which are designed primarily for non-majors. Additionally, Electives can include no more than one course at the 200 level. The remaining Electives must be at the 300 or 400 level. In choosing Electives, students are encouraged to consult with their advisors and to sample courses from across the Department.

Professional Writing B.A.

Sample Curriculum

This plan is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years not that it should or must be. In fact, as a department, we recommend beginning the major in the sophomore year if possible. Students in H&SS may declare a major as early as mid-semester of the spring of their first year and begin major requirements the following fall.

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Intro to Professional & Technical Writing 76-271	Argument 76-373	Rhetoric Course 76-3xx/4xx	Advanced Writing/Rhetoric Course 76-3xx/4xx
Style 76-390	Survey of Forms 76-26x	Advanced Writing/Rhetoric Course 76-3xx/4xx	Advanced Writing/Rhetoric Course 76-3xx/4xx
English Elective 76-3xx/4xx	English Elective 76-2xx-3xx	English Elective 76-3xx/4xx	Advanced Writing/Rhetoric Course 76-3xx/4xx
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

The B.S. in Technical Writing & Communication

The B.S. in Technical Writing & Communication (TWC) is one of the oldest undergraduate technical communication degrees in the country, and still one of the few that is a B.S. rather than a B.A. degree. The program is specifically designed to prepare students for successful careers involving scientific, technical, and computer-related communication.

The B.S. in Technical Writing reflects changes taking place in the technical communication fields. At one time in the not too distant past, technical writers worked primarily with print documents and within a relatively narrow range of fields that included the software industry and various organizations concerned primarily with scientific or technological subjects. The recent explosion of information technologies has radically changed that situation. Today's technical communicators are professional specialists with strong backgrounds in the technology, communication, and design skills needed to enter a broad range of information-based fields. The work that technical writers now do goes well beyond writing documents for print distribution. The expanding range of options includes positions that involve organizing, managing, communicating, and facilitating the use of both technical and non-technical information in a range of fields and media.

Some of the many things that technical communicators do include developing and designing web sites, explaining science and technology to the public, developing print and multimedia materials, developing information management systems, designing and delivering corporate training, and developing support systems for consumer products ranging from software for wordprocessing or personal finances to complex data management systems.

The B.S. in Technical Writing recognizes the important changes taking place in communication-based careers and includes two distinctive “tracks,” one in Technical Communication (TC) and one in Scientific and Medical Communication (SMC). Both tracks begin with a common core of foundation courses in print and on-line communication as well as a shared set of prerequisites in math, statistics, and computer programming. The two tracks differ in the

set of theory/specialization courses beyond the core, with each track including a specialized set appropriate to its focus.

In both the TC and SMC tracks, TWC students work on real projects for actual clients, learn group interaction and management skills, and develop a flexible repertoire of skills and strategies to keep up with the rapid advances in software and technology. Above all else, they focus on developing structures and information strategies to solve a broad range of communication and information design problems.

Students majoring in Technical Writing & Communication are able to draw on exceptional resources on and off campus to enhance their education. Most obvious are the course offerings of Carnegie Institute of Technology, the Mellon College of Science, and the School of Computer Science. Additional course offerings in business, organizational behavior, policy and management, psychology, history, and design are also encouraged.

Students have the options of doing internships for academic credit during their junior or senior year. These internships provide a minimum of 120 hours of professional experience as well as exposure to the broad range of career possibilities that technical writers can pursue after graduation. Both coursework and internships also provide writing samples for students' professional portfolios. Recent students have done internships at various on- and off-campus sites including Rockwell Automation, Duquesne Systems, the Carnegie Mellon Robotics Institute, Claritech, Janus Technologies, and the Carnegie Mellon Software Engineering Institute (SEI). Placement patterns after graduation are similarly diverse. Graduates of the Technical Writing program have been hired by organizations nationwide. Firms recruiting and hiring Technical Writing graduates include Microsoft, Intel, AT&T, Digital Equipment, IBM, Data General, NCR Corporation, Cisco Systems, and Mellon Financial.

The Technical Communication, or TC Track

The Technical Communication track (TC) prepares students for careers in the rapidly changing areas of computer-based communication. Students learn the fundamentals of visual, verbal, and on-line communication as well as the technical skills needed to design, communicate, and evaluate complex communication systems and to manage the interdisciplinary teams needed to develop them. Students become fluent in both print-based and electronic media across a variety of information genres and learn to design information for a range of specialist and non-expert audiences. The TWC/TC major can be pursued as a primary major within H&SS or as a secondary major for students in other Colleges with an interest in combining their specialized subject matter knowledge with strong writing and communications skills. Graduates of this track are likely to follow in the footsteps of previous Technical Writing students from Carnegie Mellon who are currently employed as web designers, information specialists, technical writers, and information consultants in a range of technology and communication-based organizations including IBM, Microsoft, Apple, and Intel, all of whom actively recruit on the Carnegie Mellon campus.

The Scientific and Medical Communication, or SMC Track

The Scientific and Medical Communication track (SMC) is designed for students who seek careers that focus on communication and information design problems in these specialized areas. It should appeal to students with interests in the health care professions, science and public policy, patient education, scientific journalism and related fields. Like the TC track, the SMC track is designed to provide both the technical and the communication skills needed to analyze and solve complex communication problems. Students learn the fundamentals of visual, verbal, and on-line communication as well as the technical skills needed to design, communicate, and evaluate complex information systems and to manage the interdisciplinary teams needed to develop them. Students become fluent in both print-based and electronic media across a variety of information genres and learn to design information for a range of specialist and non-expert audiences. The TWC/SMC major can be pursued as a primary major within H&SS or as a secondary major for students in other Colleges, such as MCS, with an interest in science or medicine.

Curriculum for the TWC degree

All Technical Writing & Communication majors must satisfy the H&SS requirements for the B.S. degree, and a set of 3 to 4 prerequisite courses in calculus, statistics, and computer science. All prerequisites should be completed by the beginning of the fall semester, junior year. Prerequisites may double count toward H&SS Requirements or requirements for other majors or minors.

Mathematics Prerequisite: 1 courses, 9-10 units

Complete one of the following:

21-111	Calculus I
21-112	Calculus II
21-120	Differential and Integral Calculus

Statistics Prerequisite:

1 course, 9 units

Complete one course

36-201	Statistical Reasoning
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Computer Science Prerequisites: 2 courses, 20 units

15-100	Introductory/Intermediate Programming (10 units)
and	
15-111	Intermediate/Advanced Programming (10 units) *

* The 15-100 and 15-111 sequence is designed and paced for students in the Technical Communication and similar degrees who have not had prior programming experience. Students with little or no prior experience with computer science or programming might also consider taking 15-105 Concepts of Computation as one of their Technical Communication Electives and may find it useful to do so before taking 15-100.

Beyond these prerequisites, students in both TC and SMC tracks take a common set of 5 TWC Core Requirements in writing, communication, and information design. To complement these foundations courses, TWC students take a set of 3 Theory/Specialization courses specific to either TC or SMC. In addition, students in the SMC track take a series of 3 courses in the natural sciences or engineering relevant to their areas of interest, while TC students take 3 electives in management, technology, and social issues.

Technical Communication Track

TWC Core Requirements 5 courses, 52 units

Complete all 5 courses.

76-26x	Survey of Forms (Creative Nonfiction, Fiction, Poetry, or Screenwriting)
76-271	Introduction to Professional & Technical Writing
76-390	Style
76-391	Document Design *
76-487	On-Line Information Design **

* prerequisite = 76-271

** prerequisite = 76-271 + 76-391

Theory/Specialization Courses 3 courses, 27 units

Complete 3 Advisor-approved courses structured as follows.

At least one of the three must be chosen from the 3 "Recommended" options below. The remaining 2 courses can be from the "Recommended" or "Additional Options" lists.

Recommended Options — at least one Elective MUST be from this set (and all three should be strongly considered as options)

76-491	Software Documentation * (new course beginning spring 07)
76-481	Writing for Multimedia *
76-397	Instructional Design * or 76-359 Planning and Testing Documents

Additional Options

76-318	Communicating in the Global Marketplace *
76-476	Rhetoric of Science
76-395	Science Writing *
76-380	Research Methods for Writers
76-385	Intro to Discourse Analysis
76-386	Language & Culture
76-387	Intro to Sociolinguistics
76-389	Grammar
76-392	Rhetoric & Public Policy
76-419	Communication Revolutions & Technologies
76-301	Internship *
39-605/6	Product Design

* Courses with prerequisites. Check course descriptions for details.

Additional courses that fulfill these requirements may be available and will be announced on a semester-by-semester basis

Technical Communication Electives 3 courses, 27 units

Complete 3 advisor-approved electives in management, technology, and social issues, chosen from the following options. Additional options may be advertised on a semester-by-semester basis. Note that at least some of these courses may have prerequisites. Please check course listings for details and plan accordingly. Courses in this category may double count for both the TWC/TC degree and a major or minor in another department.

05-410	Human Computer Interaction Methods
05-413	Human Factors
05-499	Social Issues in Computing
15-105	Concepts in Computation
15-xxx	Computer Science courses beyond the 2 required
19-211	Computer and Society
19-403	Policies of Wireless Systems and the Internet
19-448	Science, Technology, and Ethics
36-203	Sampling, Surveys, and Society
36-309	Experimental Design for Behavioral and Social Sciences
36-350	Data Mining
51-261/2	Communication Design Fundamentals
51-263/4	Industrial Design Fundamentals
70-311	Organizational Behavior
70-332	Business, Society, and Ethics
70-342	Managing Across Cultures
79-209	Theory & Practice in Anthropology
79-212	Technology and the Environment in Global Historical Context
79-230	Technology in American Society
79-358	Complex Technological Systems: Past, Present, Future
80-220	Philosophy of Science
80-221	Philosophy of Social Science
80-241	Ethical Judgments in Professional Life
80-242	Conflict Dispute Resolution
80-243	Business Ethics
80-244	Environment, Management and Ethics
80-291	Issues in Multimedia Authority
80-300	Minds, Machines, and Knowledge
80-341	Computers, Society, and Ethics
80-300	Minds, Machines, and Knowledge
85-211	Cognitive Psychology
85-213	Human Information Processing and Artificial Intelligence
85-241	Social Psychology
85-370	Perception
85-392	Human Expertise
85-395	Applications of Cognitive Psychology
85-413	Human Factors
85-417	Cognitive Modeling and Intelligent Tutoring Systems
88-223	Decision Analysis & Decision Support Systems
88-260	Organizations
88-341	Organizational Communication
88-366	Social Issues in Computing

Scientific & Medical Communication Track

Core Requirements for TWC: 5 courses, 52 units

Complete all 5 courses.

76-26x	Survey of Forms (Creative Nonfiction, Fiction, Poetry, or Screenwriting)
76-271	Introduction to Professional & Technical Writing
76-390	Style
76-391	Document Design *
76-487	On-Line Information Design **

* prerequisite = 76-271

** prerequisite = 76-271 + 76-391

Theory/Specialization Courses: 3 courses, 27 units

Complete 3 advisor-approved courses structured as follows:

At least one of the three must be chosen from the 3 "Recommended" options below. The remaining 2 courses can be from the "Recommended" or "Additional Options" lists.

Recommended Options — at least one Elective MUST be from this set (and all three should be strongly considered as options).

76-476	Rhetoric of Science
76-395	Science Writing *
76-494	Healthcare Communications *

Additional Options

76-481	Writing for Multimedia *
76-318	Communicating in the Global Marketplace *
76-419	Communications Revolutions and Technologies
76-359	Planning and Testing Documents
76-385	Intro to Discourse Analysis
76-386	Language & Culture
76-387	Intro to Sociolinguistics
76-389	Grammar
76-392	Rhetoric & Public Policy
76-396	Writing, Advocacy, and Public Policy*
76-397	Instructional Design *
76-491	Software Documentation
76-301	Internship *
36-203	Sampling, Surveys, and Society
36-309	Experimental Design for Behavioral and Social Sciences
39-605/6	Product Design
79-234	Body Politics: Women and Health in America
79-334	Health Policy: Historical Perspectives
79-335	Drug Use and Drug Policy
79-358	Complex Technological Systems: Past, Present, Future
79-384	Medicine and Society
79-385	History of Biomedical Research
80-220	Philosophy of Science
80-225	History and Philosophy of Science I
80-244	Management, Environment, and Ethics
80-245	Medical Ethics
88-223	Decision Analysis & Decision Support Systems

* English Department courses that have prerequisites. Course options in other departments may also have prerequisites. Please check appropriate departmental course listings for details. Additional options may be available and will be announced on a semester-by-semester basis.

Natural Sciences & Engineering:
3 courses, 27 units

Complete 3 advisor-approved courses that contribute to the student's chosen focus. The courses may be all in one area such as biology, or spread across areas. The basic courses in biology, chemistry, and physics are listed below. Additional options include advanced courses in any of these areas as well as basic and advanced classes in statistics, or engineering. Consult your English Department advisor on the appropriateness of specific courses for your interests. Courses in this category may double count for both the TWC/TC degree and a major or minor in another department.

03-121	Modern Biology
03-321/2	Biochemistry
09-105	Modern Chemistry I

09-106	Modern Chemistry II
09-221	Lab I: Intro to Chemical Analysis
33-111	Physics for Science Students I
33-112	Physics for Science Students II
42-101	Introduction to Biomedical and Health Engineering
42-202	Physiology
76-341	Intro to Biomechanics
42-347	Rehabilitation Engineering
42-444	Medical Devices

TWC / TC Track

Sample Curriculum

This plan is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years not that it should or must be. In fact, as a department, we recommend beginning the major in the sophomore year if possible. Students in H&SS may declare a major as early as mid-semester of the spring of their first year and begin major requirements the following fall.

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Intro to Professional & Technical Writing 76-271	Style 76-390	Document Design 76-391*	On-Line Information Design 76-487+488*
Survey of Forms 76-26x	Theory/ Specialization Course	Theory/ Specialization Course	Theory/ Specialization Course
TC Elective	TC Elective	TC Elective	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

* Because of prerequisites and course scheduling, it is critical that these courses be taken in this order and in the semester (fall or spring) indicated in order to complete the degree in two years.

Technical Writing & Communication, SMC Track

Sample Curriculum

This plan is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years not that it should or must be. In fact, as a department, we recommend beginning the major in the sophomore year if possible. Students in H&SS may declare a major as early as mid-semester of the spring of their first year and begin major requirements the following fall.

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Intro to Professional & Technical Writing 76-271	Style 76-390	Document Design 76-391*	On-Line Information Design 76-487+488*
Survey of Forms 76-26x	Theory/ Specialization Course	Theory/ Specialization Course	Theory/ Specialization Course
Natural Science/ Engineering Course	Natural Science/ Engineering Course	Natural Science/ Engineering Course	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

* Because of prerequisites and course scheduling, it is critical that these courses be taken in this order and in the semester (fall or spring) indicated in order to complete the degree in two years.

Completing an Additional Major in English

Students with interests that include more than one of the department's degrees have the option of completing a double major within the department. Students may double major in any combination of the B.A. degrees or combine the B.S. in Technical Writing and Communication with either the B.A. in English or the B.A. in Creative Writing. Students may not combine the B.A. in Professional Writing and the B.S. in Technical Writing for a double major because so many of the courses overlap.

Students majoring in two or more English Department degrees must fulfill the Core Requirements for the Major for both programs. The English Department Core Course — Survey of Forms — needs to be taken only once to count toward both majors. Similarly, the English Electives need to be taken only once and can count toward both majors with the understanding that a student must complete the number of English Electives required by the program with the higher number of Electives. For example, a student double-majoring in the B.A. in English and the B.A. in Creative Writing would take the 4 English Electives required for Creative Writing.

Because the English Department Core course and the English Electives are allowed to double count toward both majors, students who are already majoring in one of the English degrees can generally add a second English major by completing 5 to 6 additional courses. For example, a student who has fulfilled all 11 requirements for the BA in English can complete the BA in Creative Writing by adding the 6 courses of the Creative Writing Core: one additional Survey of Forms course, one Reading in Forms course, and 4 Writing Workshops. Because sequencing of courses can become an issue when doing multiple majors, students are strongly advised to consult closely with their English Department advisors about the sequence of their courses.

Completing a Secondary Major in English

Students in other departments who wish to complete a secondary major in the English Department should contact the Academic Coordinator in the English Department Office to file an additional major application form and be assigned to an English Department advisor. Secondary majors in the four English degrees are required to complete all requirements for the chosen major. Additionally, courses taken to fulfill requirements within the primary major may not double count for requirements within the chosen English Department degree. The only exceptions to this rule are the TC electives for the TWC/TC degree and the Natural Science and Engineering requirements for the TWC/SMC degree. In planning schedules for an additional major, it is critically important that students consult with both departments in which they are majoring to be sure that all requirements for graduation can be met.

Minor in English

The English Department also offers a minor in English, with concentrations in Creative Writing, English Studies, Professional Writing, and Technical Writing. The minor requires a minimum of five courses (45 units), plus completion of (or credit for) 76-101 or an equivalent requirement. The minor in English is available to all undergraduate students except English majors, who may not both major and minor in English.

Courses taken to fulfill requirements in other major or minor programs may not be applied to English minor requirements (and vice versa).

Courses that meet the various requirements are advertised on a semester-by-semester basis. Full descriptions are available each semester from the English Department main office. We also publish a document titled "What Counts for What for Minors," which indicates which courses offered in a given term fulfill specific requirements in each of the minor concentrations.

English Studies Concentration

Complete 6 courses, including 76-101 as a prerequisite.

76-101	Interpretation & Argument (or credit for equivalent course)
76-294	Interpretive Practices (prerequisite for 300- and 400-level courses)
76-3xx	Two 300-level courses in Literature, Cultural Studies or Rhetoric

76-3xx/4xx One additional 300-level course or a 400-level seminar in Literature, Cultural Studies, or Rhetoric *
76-xxx One 200-level or above English Elective **

* Note that at least some 400-level seminars have 76-394: Research in English Studies as a pre- or co-requisite. Students planning to take a 400-level seminar to fulfill this requirement should plan to take 76-394 as one of their 300-level courses.

** The English Elective may be any course offered by the English Department except 76-201, 76-205, and 76-206, all of which are designed primarily for non-majors.

Creative Writing Concentration

Complete 6 courses, including 76-101 as a prerequisite.

76-101 Interpretation & Argument (or credit for equivalent course)
76-260/265 Survey of Forms: Fiction* or Poetry *
76-36x/46x Two Fiction or Poetry Workshop courses
76-3xx One Reading in Forms Course
76-xxx One 200-level or above English Elective **

* A student must receive a grade of A or B in the Survey of Forms class in order to be eligible to enroll in a workshop of that genre. A student who receives a grade of C in a Survey of Forms course may enroll in a related workshop only with the permission of his or her workshop professor. A student who receives a D or R in Survey of Forms may not take a workshop in that genre.

** The English Elective may be any course offered by the English Department except 76-201, 76-205, and 76-206, all of which are designed primarily for non-majors.

Professional Writing Concentration

Complete 6 courses, including 76-101 as a prerequisite.

76-101 Interpretation & Argument (or credit for equivalent course)
76-270 Writing in the Professions
or
76-271 Introduction to Professional & Technical Writing
76-3xx/4xx Two 300- or 400-level Writing courses *
76-3xx/4xx One Rhetoric/Language Studies course
76-xxx One 200-level or above English elective

* 76-270 or 76-271 is generally the prerequisite for these 300- and 400-level courses. Options include 76-318, 76-319, 76-372, 76-375, 76-389, 76-390, 76-391, 76-395, 76-396, 76-397, 76-461, 76-472, 76-479, 76-481, 76-487, 76-491, 76-494, and other options advertised on a semester-by-semester basis.

Technical Writing Concentration

Complete 6 courses, including 76-101 as a prerequisite.

76-101 Interpretation & Argument (or credit for equivalent course)
76-271 Introduction to Professional & Technical Writing
76-3xx/4xx Two 300- or 400-level courses* from these options:

76-318	Communicating in the Global Marketplace
76-383	Multimedia Authoring II
76-385	Introduction to Discourse Analysis
76-390	Style
76-391	Document Design
76-395	Science Writing
76-397	Instructional Design
76-392	Rhetoric and Public Policy
76-487	On-Line Information Design
76-476	Rhetoric of Science
76-481	Writing for Multimedia
76-491	Software Documentation
76-494	Healthcare Communication

76-3xx/4xx One Rhetoric/Language Studies course
76-xxx One 200-level or above English Elective

* 76-271 is a prerequisite for these courses. Additionally, 76-480 is a prerequisite for 76-487.

Senior Honors Thesis

Seniors in all four majors in the English Department who meet the necessary requirements are invited by the College of Humanities and Social Sciences (H&SS) to propose and complete a Senior Honors Thesis during their final year of study. The thesis may focus on research and/or original production in any of the areas offered as a major within the Department. To qualify for the H&SS Honors Program, students must have a cumulative Quality Point Average of at least 3.50 in their major and 3.25 overall at the end of their junior year and be invited by H&SS to participate. Students then choose a thesis advisor within the Department and propose and get approval from H&SS for a Senior Honors Thesis. The Honors Thesis is completed over the two semesters of the senior year (9 units each semester) under the direction of the chosen advisor. By successfully completing the thesis, students earn 18 units of credit and qualify for graduation with "College Honors."

Internship Program

Qualified students in all four of the Department's degree programs have the option of doing one or more professional internships for academic credit during their junior or senior years. These opportunities help students explore possible writing-related careers as well as gain workplace experience. Each internship is arranged, approved, and overseen by the Department's Internship Coordinator. Particular attention is given to matching students to internship sites of specific interest to them. Students have interned in a wide variety of communications-related positions including placements at local radio, television, and print publications; museums, theaters, and cultural organizations; non-profit and public service organizations; public relations, advertising, and marketing firms; software and technology companies; and hospitals and medical communication concerns.

To be eligible for an internship, students must have a Quality Point Average of 3.0 or better and credit for at least one writing course (including Survey of Forms) beyond 76-101. Internships generally carry 3-9 units of credit. A 9-unit internship is the standard and requires a minimum of 120 hours (8-10 hours per week) of work at the internship site during the term. In addition, interns complete a reflective journal and a series of short research and writing assign-ments relevant to the specific internship. Students doing an internship for credit must be registered for the internship during the term (including summer) when they are working at the internship site.

The MAPW 4+1 Program

The MAPW 4+1 is a special program under which Carnegie Mellon students (usually majors or minors in the English department or BHA or BHS students with relevant coursework) can qualify to complete the MA in Professional Writing in 2 semesters instead of the usual 3. Students apply for admissions during their junior or senior year and, following admission and evaluation of their transcripts, may receive credit for up to four courses, or one full semester of work toward the MA requirements. The degree has a professional focus, combines intensive work in both writing and visual design, and prepares students for a range of communications careers. The coursework and career options most commonly pursued by students in the degree include

- Writing for New Media, including web design and information design
- Writing for Print Media, including Journalism
- Editing & Publishing
- Technical writing, including instructional design
- Science, Technology, and Healthcare Writing
- Public & Media Relations / Corporate Communications

4+1 students are also eligible to apply for the department's new masters degree in Investigative Journalism, which involves study abroad and an additional semester of coursework during which students complete an investigative project and related thesis under the joint supervision of faculty in both Scotland and Pittsburgh.

Students interested in applying to the 4+1 program should consult the Director of the MAPW program early in their junior year for further details and advice on shaping undergraduate coursework to qualify for this option. Detailed information on the program and relevant financial aid is available at <http://english.cmu.edu/> under the tab for the MAPW or from the English Department office.

Faculty

MARIAN AGUIAR, Assistant Professor of English and Literary and Cultural Studies — Ph.D., University of Massachusetts; Carnegie Mellon, 2002 —.

JANE BERNSTEIN, Professor of English and Creative Writing — M.F.A., Columbia University; Carnegie Mellon, 1991 —.

CLAUDIA CARLOS, Assistant Professor of English — Ph.D., University of Illinois; Carnegie Mellon, 2005—.

GERALD P. COSTANZO, Professor of English and Creative Writing — M.A., M.A.T., Johns Hopkins University; Carnegie Mellon, 1970—.

JAMES DANIELS, Thomas S. Baker Professor of English and Creative Writing — M.F.A., Bowling Green State University; Carnegie Mellon, 1981—.

SHARON DILWORTH, Associate Professor of English and Creative Writing — M.F.A., University of Michigan; Carnegie Mellon, 1989—.

LINDA FLOWER, Professor of English and Rhetoric — Ph.D., Rutgers University; Carnegie Mellon, 1980—.

YONA HARVEY, Visiting Professor of Creative Writing — MFA, The Ohio State University; Carnegie Mellon, 2007—.

TERRANCE HAYES, Professor of Creative Writing — M.F.A, University of Pittsburgh; Carnegie Mellon, 2001—.

PAUL HOPPER, Paul Mellon Distinguished Professor of the Humanities, Rhetoric and Linguistics — Ph.D., University of Texas; Carnegie Mellon, 1990—.

SUGURU ISHIZAKI, Associate Professor of Rhetoric and Visual Design — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2005— .

BARBARA JOHNSTONE, Professor of Rhetoric and Linguistics — Ph.D., University of Michigan; Carnegie Mellon, 1997—.

DAVID S. KAUFER, Professor of English and Rhetoric; Head of the English Department — Ph.D., University of Wisconsin; Carnegie Mellon, 1980—.

ALAN KENNEDY, Professor of English — Ph.D., University of Edinburgh; Carnegie Mellon, 1989—.

JON KLANCHER, Associate Professor of English — Ph.D., University of California at Los Angeles; Carnegie Mellon, 1999—.

PEGGY A. KNAPP, Professor of English — Ph.D., University of Pittsburgh; Carnegie Mellon, 1970—.

HILARY MASTERS, Professor of English and Creative Writing — A.B., Brown University; Carnegie Mellon, 1983—.

JANE McCAFFERTY, Associate Professor of English and Creative Writing — M.F.A., University of Pittsburgh; Carnegie Mellon, 1997—.

CHRISTINE NEUWIRTH, Professor of English and Human Computer Interaction — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1983—.

KATHLEEN NEWMAN, Associate Professor of English and Literary and Cultural Studies — Ph.D. Yale University; Carnegie Mellon, 1997—.

RICHARD PURCELL, Assistant Professor of English — Ph.D., University of Pittsburgh; Carnegie Mellon, 2008—.

ANDREEA RITIVOI, Associate Professor of English — Ph.D., University of Minnesota; Carnegie Mellon, 2001—.

KAREN SCHNAKENBERG, Teaching Professor of Rhetoric and Professional Writing; Director of Masters in Professional Writing Program — Ph.D. Carnegie Mellon University; Carnegie Mellon, 1995 —.

DAVID R. SHUMWAY, Professor of English and Literary and Cultural Studies — Ph.D., Indiana University; Carnegie Mellon, 1985—.

ERWIN R. STEINBERG, Professor Emeritus of English and Rhetoric — Ph.D., New York University; Carnegie Mellon, 1946—.

KRISTINA STRAUB, Professor of English and Associate Head of the English Department — Ph.D., Emory University; Carnegie Mellon, 1987—.

DANIELLE WETZEL, Assistant Teaching Professor and Director of First-Year English — Ph.D. Carnegie Mellon University; Carnegie Mellon, 2006 —.

JEFFREY WILLIAMS, Professor of English and Literary and Cultural Studies — Ph.D. SUNY— Stonybrook; Carnegie Mellon, 2004 —.

JAMES WYNN, Assistant Professor of English — Ph.D., University of Maryland; Carnegie Mellon, 2006—.

Department of History

Joe W. Trotter, Department Head
 Department Office: Baker Hall 240
www.hss.cmu.edu/departments/history

Undergraduate programs in History focus on new ways to understand the past and new ways to use what we know. The programs all deal with connections between past and present and the ways historical understanding facilitates the assessment of social, cultural, and policy change. The programs emphasize analysis and empirical methods in developing conceptual understanding. In addition, specific research skills relevant to many types of jobs as well as to further professional training are taught. The Department's mission also includes courses introducing students to various societal settings and diverse types of controversial public issues, thus contributing actively to students' liberal and professional development.

Each of the History programs combines a structured sequence, training in research methods and relevant theory, and a considerable array of electives. Each program stems from the teaching and research strengths of a department that has led in the formulation of a number of innovative approaches to the study of social and policy change. Carnegie Mellon's Department of History is nationally known for its strength in three broad areas: Social and Cultural History, History and Policy, and Anthropology and History. Social and Cultural History is the effort to understand the past as it was experienced and shaped by people at various levels, from lower class to elite. Social historians do research in such areas as how families and communities developed, how people's work lives were organized and how they used their leisure time, what they believed and felt, and how they related to the authority of the state and other sources of power in their particular society. History and Policy uses historical explanation and analysis to inform the interpretation and formulation of policy in both the public and private sectors. Policy historians bring to contemporary social issues a perspective on change and innovation that others (for example, legislators or operations researchers) often lack. Anthropology and History takes advantage of the fruitful interaction between theories and methodologies elaborated in both disciplines to provide a more profound analysis of the societies and cultures of the people that they study.

The History Department supports several research centers to coordinate sponsored research by faculty and graduate students. The research centers include the Center for History and Policy (Caroline Acker, Director) and the Center for African American Urban Studies and the Economy (CAUSE) (Joe W. Trotter, Director). The department also supports the Center for Historical Information Systems and Analysis (CHISA) (David Miller, Director).

The Department of History offers B. A. and B. S. degrees in Social and Cultural History, History and Policy, and Anthropology and History. Each of these majors is described below.

The Majors in History

The study of history involves not only the mastery of a body of subject matter, but also the development of a range of skills which are broadly applicable in modern society. Exploration of patterns in the past aids in understanding the workings of human society, while historical research and study promote abilities in handling and interpreting data that have a variety of uses. The Carnegie Mellon History programs are devoted to innovative approaches to history and to the development of key skills.

History provides a springboard to a number of career options. There is, of course, a profession of history, composed largely, but not exclusively, of historians who teach and conduct research in colleges and universities. The normal way to enter that profession is to complete a Ph.D. in the history department of a major university, and several undergraduate students with a major in the History Department go on to do just that. Most students who complete a major in the History Department, however, do not become professional historians in the sense that this term is normally used. History as a major is often chosen by students who plan to enter a profession which will require training in a post-baccalaureate professional school, such as law, business administration, public policy, urban planning, librarianship, journalism, the ministry, or

social work. Most schools in these fields prefer students who have used their undergraduate years to acquire a strong liberal education and a broad perspective on human problems such as one gained by majoring in History, rather than students with narrowly specialized programs and skills.

History is also excellent preparation for certain specific careers which can be entered immediately upon graduation. The U. S. Foreign Service is one traditional avenue for History majors, especially those who have also acquired language skills, and there are a number of other government agencies that recruit History and other liberal arts graduates. Because History courses emphasize research and writing skills plus analysis of social and policy trends, journalism and editorial work are also natural careers for History majors.

The horizons for a student with a major in the History Department include business careers as well. Most majors in the History Department, at Carnegie Mellon and elsewhere, take jobs in business, and research shows that History majors have better than average career success in management. Because they have been trained to analyze subtle and complex issues, because they develop breadth of understanding, because they are accustomed to digging out information and making sense of it, and because they have learned to present their findings effectively, students with a major in the History department do extremely well in many different types of organizations, both public and private, throughout their careers. A major in History provides the general skills and sense of perspective that continue to be of value as one advances to positions of greater responsibility in an organization. At the same time, Carnegie Mellon History majors are encouraged to take full advantage of complementary areas of study in the College and the University that offer other specific skills and perspectives that are an important professional addition to a major in History. Some students combine History with work in another specialty such as Business, Economics, Professional Writing, Statistics, Philosophy, Political Science, or Modern Languages.

The Department also offers a minor in History. Several other minors, described throughout this catalog, can be linked with any of the History majors to provide additional depth. These include H&SS minors in such fields as African and African American Studies; Gender Studies; Film and Media Studies; Global Politics; Religious Studies; Environmental Studies; Policy and Management; Russian Studies; and Science, Technology and Society. Additional examples include minors offered in the arts, engineering, science, mathematics, business, and computer science.

History is also a key component of four other majors described elsewhere in this catalog: Ethics, History, and Public Policy; European Studies; Russian Studies; and Global Politics.

The Major in Anthropology and History

Students who major in Anthropology and History learn to use both disciplines in analyzing pattern and change in human societies. The major examines the ways in which anthropological theories and methods can enrich an understanding of historical processes and events. The major also points to the ways historical method can strengthen the cross-cultural and ethnographic approaches central to anthropology. Throughout, the value of interdisciplinary work is emphasized.

In two preliminary courses, students are exposed to the basic concepts and perspectives of each discipline. At the intermediate level they select from two sets of courses combining historical and anthropological analysis: thematic courses that relate culture and symbols to institutions, daily life, and social change; and regional courses that allow students to study an evolving culture and society in its own terms as well as ours. In the senior year, students undertake original research which may combine field work and archival work.

Besides supplying a solid preparation for graduate work in history or anthropology, the major offers a gateway to careers in journalism, law, government, and business, especially as these address matters of multicultural or international concern. Its training in comparative

and historical thinking will also be valuable in such professions as teaching, design, and medicine.

Curriculum

Students majoring in Anthropology and History normally are awarded a B.A. degree. The B.S. degree is awarded when it is deemed appropriate after a review of a student's overall undergraduate record including second majors, minors, and elective courses. Students should consult with the departmental advisor about their course of study when declaring their major.

Prerequisite Course 9 units
 79-104 Introduction to World History

Survey Course 9 units
 79-201 Introduction to Anthropology

Historical Evidence and Interpretation (1) 12 units
 79-200 Historical Evidence and Interpretation

This course focuses on a single critical event in history (e.g., the French Revolution, the Cuban missile crisis). Materials in the course will include examples of various types of explanation as well as primary sources. The course is a common experience for students in this major and in the History and Policy and the Social and Cultural History majors.

Theory and Practice in Anthropology (1) 9 units
 79-209 Theory and Practice in Anthropology

Regional Courses (3) 27 units

Choose three from among the following courses in African, Asian, European, and Latin American/Caribbean history. At least one of the courses must be a non-European course.

- 79-207 Development of European Culture
- 79-253 Development of Caribbean Culture
- 79-255 Irish History
- 79-258 Introduction to African History II: 18th Century to Neo-Colonialism
- 79-260 Mayan America
- 79-267 Pre Colonial West African History 1100 to 1800
- 79-268 From the Local to the Global: Globalization in East African History
- 79-270 Chinese Culture and Society
- 79-271 Modern China
- 79-288 Bananas, Baseball, and Borders: A History of Latin America-U.S. Relations
- 79-289 Development and Democracy in Latin America
- 79-290 Between Revolutions: The Development of Modern Latin America
- 79-307 The Anthropology of Europe
- 79-310 Modern Spain: Culture, Politics and Society
- 79-319 The City and the Country in Modern Europe
- 79-356 Introduction to African History I: Earliest Times to the

Thematic Courses (2) 18 units

Choose two courses from among the following:

- 79-303 Visual Anthropology
- 79-308 The Politics and Culture of Memory
- 79-312 Medical Anthropology
- 79-348 Objects of Value
- 79-364 Art, Anthropology, and Empire
- 79-392 Dilemmas and Controversies in Anthropology
- 79-404 Extreme Ethnography

Advanced Studies in Anthropology and History (1) 12 units
 79-400 Advanced Studies in Anthropology and History*

*prerequisites: 79-200, 79-201 and 79-209

Anthropology and History, B.A. and B.S.

Sample Curriculum

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Introduction to Anthropology 79-201	Theory & Practice 79-209	Intermediate Regional Course 79-xxx	Intermediate Regional Course 79-xxx
Intermediate Thematic Course 79-xxx	Intermediate Regional Course 79-xxx	Advanced Studies in Anthropology and History 79-400	Elective
Historical Evidence & Interpretation 79-200	Intermediate Thematic Course 79-xxx	Elective	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years; not that it must be. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the first year. Students should consult their advisor when planning their program.

Additional Major

Anthropology and History may be scheduled as an additional major in consultation with the departments concerned.

The Major in History and Policy

The History and Policy major is designed to develop a special kind of policy analyst who applies the skills and interests of historians to current problems of policy in government and business. Besides providing a thorough grounding in historical analysis, the History and Policy major includes courses on theories of public policy and the role of the state. Other courses focus on specific policy areas such as urban planning, business development and regulation, the environment, public health, criminal justice, foreign policy, education, and social welfare. The major culminates with the History and Policy Project Course, in which students act as a team of consultants who apply historical research to a contemporary policy problem and present the results to a client organization in the community. The major will strengthen a student's qualifications for a variety of positions in research, management, policy analysis, and policy development.

Historical perspective enriches policy analysis in several ways. Majors in History and Policy use historical analysis and archival research to investigate the ways in which decisions have been made in societies in the past, with the goal of bringing historical understanding to bear on the making of decisions in the present and on projects for the future. History and Policy prepares students to use comparisons with past policy effectively so that experience can properly contribute to recommendations and decision-making in the present. It develops an ability to assess social trends, in order to establish both continuities and discontinuities as the context for determining appropriate policy. Students also apply tools from other disciplines such as the social sciences to evaluate policy problems and to study how problems have been recognized, formulated, and assessed.

Carnegie Mellon has pioneered in the systematic application of historical perspective to policy issues. The History and Policy major prepares students for work in a number of policy areas while also serving as excellent preparation for graduate work in public policy, management, law, public health, journalism, social work, and business administration. At the same time, students are broadly prepared for intelligent participation in decision making in the leading problem areas of contemporary society.

Curriculum

Students majoring in History and Policy normally are awarded a B.A. degree. The B.S. degree is awarded when it is deemed appropriate after a review of a student's overall undergraduate record including second majors, minors, and elective courses. Students should consult with the departmental advisor about their course of study when declaring their major.

Prerequisite Course 9 units

79-104 Introduction to World History

Survey Course 9 units

Choose one survey course from among the following:

- 79-206 Development of American Culture
- 79-207 Development of European Culture
- 79-253 Development of Caribbean Culture
- 79-258 Introduction to African History II: 18th Century to Neo-Colonialism
- 79-270 Chinese Culture and Society
- 79-280 Russian History: From the First to the Last Tsar
- 79-281 Russian History: From Communism to Capitalism
- 79-290 Between Revolutions: The Development of Modern Latin America
- 79-356 Introduction to African History I: From the Earliest Times to the Origins of the Slave Trade

Historical Evidence and Interpretation (1) 12 Units

79-200 Historical Evidence and Interpretation

This course focuses on a single critical event in history (e.g., the French Revolution, the Cuban missile crisis). Materials in the course will include examples of various types of explanation as well as primary sources. The course is a common experience for students in this major and in the Anthropology and History and the Social and Cultural History majors.

History and Policy Introductory Courses (2) 18 units

- 79-202 The History of Public Policy in the United States
- 79-208 Theory and Practice in History and Policy*

* Prerequisite: 79-202; Open only to declared majors in History and Policy

Public Agenda History Courses (4)* 36 units

Choose four courses from among the following; at least one of the four courses must have an international orientation.

- 79-230 Technology in American Society
- 79-231 American Foreign Policy: 1945 to the Present
- 79-232 Vietnam: America's Lost War
- 79-233 The United States and the Middle East Since 1945
- 79-242 African-American History II
- 79-244 Pittsburgh and the Transformation of Modern Urban America
- 79-248 History and Theory of Property: Land, Bodies, Ideas and Information
- 79-256 Biology and Society: Evolution, Animal Experimentation and Eugenics
- 79-263 From Soil to Oil: Energy and the Environment in the Americas
- 79-282 The Soviet Union in World War II: Military, Political and Social History
- 79-288 Bananas, Baseball, and Borders: A History of Latin America-U.S. Relations
- 79-289 Development and Democracy in Latin America
- 79-296 Genes, Clones and Stem Cells: Biology and Society in the 20th Century and Beyond
- 79-306 African American Urban History
- 79-309 Public Policy and American Military Recruitment: Historical Perspective
- 79-330 The American Presidency
- 79-332 Juvenile Delinquency: Images, Realities and Public Policy 1800-1940
- 79-335 Drug Use and Drug Policy
- 79-336 Epidemic Disease and Public Health
- 79-337 Educational Policy: Historical Perspectives
- 79-342 Introduction to Science and Technology Studies
- 79-344 Science, Technology and the Cold War
- 79-345 American Environmental History: Critical Issues
- 79-354 Stalin and Stalinism

- 79-358 Complex Technological Systems: Past, Present, and Future
- 79-368 Poverty, Charity and Welfare
- 79-397 Religion and Politics in the Middle East
- 79-440 Perspective on Industrial Research and Development

* With advance approval by the Undergraduate Advisor, students may substitute one social science course from another department or school (e.g., SDS, EPP, Philosophy, Statistics, Heinz School) that adds depth to specific policy history interests.

History and Policy Project Courses (2) 18 units

- 79-409 History and Policy Project Course Mini*
- 79-410 History and Policy Project Course**

* Prerequisites: 79-200, 79-202, 79-208
 ** Prerequisites: 79-200, 79-202, 79-208, 79-409

History and Policy, B.A. and B.S.

Sample Curriculum

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Survey Course 79-xxx	Public Agenda Course 79-xxx	History and Policy Project Course 79-410	Public Agenda Course 79-xxx
Historical Evidence & Interpretation 79-200	Theory and Practice in History and Policy 79-208	Public Agenda Course 79-xxx	Elective
The History of Public Policy in the U.S. 79-202	History and Policy Project Course Mini 79-409	Public Agenda Course 79-xxx	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years, not that it must be. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the first year. Students should consult their advisor when planning their program.

Additional Major

History and Policy may be scheduled as an additional major in consultation with the departments concerned.

The Major in Social and Cultural History

The Department has a national reputation in Social and Cultural History. Social and Cultural History can best be understood as the effort to understand the past as it was experienced and shaped by people at various social levels, from lower classes to elite. The Social and Cultural History major involves courses in labor, immigration, race, gender, politics and leisure, as well as in the history of culture. The Social and Cultural History major is also explicitly comparative in nature, reflecting a multi-cultural approach to the study of history. The major, finally, allows a wide range of choice in electives.

The Social and Cultural History major provides a good background for a wide variety of careers. It is excellent preparation for professional studies, such as law, but also for management programs and the ministry. Many Social and Cultural History majors also find employment in government, business, and with public action groups, or in any field that prizes the ability to analyze materials and to write and think clearly.

Curriculum

Students majoring in Social and Cultural History normally are awarded a B.A. degree. The B.S. degree is awarded when it is deemed appropriate after a review of a student's overall undergraduate record including second majors, minors, and elective courses. Students should consult with the departmental advisor about their course of study when declaring their major.

Prerequisite Course	9 units
79-104 Introduction to World History	
Survey Courses (2)	18 units
79-206 Development of American Culture	
79-207 Development of European Culture	
Historical Evidence and Interpretation (1)	12 Units
79-200 Historical Evidence and Interpretation	

This course focuses on a single critical event in history (e.g., the French Revolution, the Cuban missile crisis). Materials in the course will include examples of various types of explanation as well as primary sources. The course is a common experience for students in this major and in the Anthropology and History and the History and Policy majors.

Social & Cultural History	
Distribution Requirements (5)	45 units
Five history courses at the 200/300 level. Of these five courses:	
- one must be on African, Asian, Latin American/Caribbean, or Russian history,	
- one must be substantially devoted to the period before 1900,	
- two must deal with the same major geographic region (e.g. U.S., Europe, Russia, Latin America/Caribbean, East Asia).	
- one additional course	
No Double-Counting	

Advanced Studies in Social and Cultural History (1)	12 units
79-420 Advanced Studies in Social and Cultural History *	

*prerequisite: 79-200

***Majors in Social and Cultural History are also encouraged to consult with faculty about opportunities for undertaking their own research projects by enrolling in 79-421, Social and Cultural History Research Seminar and/or completing a Senior Thesis.

Social and Cultural History, B.A. and B.S. Sample Curriculum

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Historical Evidence & Interpretation 79-200	Development of American Culture 79-206	Advanced Studies in Social and Cultural History 79-420	Distribution Course Requirement 79-xxx
Distribution Course Requirement 79-xxx	Distribution Course Requirement 79-xxx	Development of European Culture 79-207	Distribution Course Requirement 79-xxx
Elective	Elective	Distribution Course Requirement 79-xxx	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years; not that it must be. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the first year. Students should consult their advisor when planning their program.

Additional Major

Social and Cultural History may be scheduled as an additional major in consultation with the departments concerned.

Interdepartmental Majors Involving History

The History Department co-sponsors the Ethics, History, and Public Policy Major with the Philosophy Department, the European Studies Major with the Modern Languages Department, and the Russian Studies Major with the Modern Languages Department. The History Department also contributes to the Global Politics Major in the Social and Decision Sciences Department. For further information, please see Interdepartmental Majors under the H&SS section of this catalog.

The Minor in History

The minor in History involves a minimum of 54 units of course work (not including the 9-unit prerequisite), as described below.

Curriculum (minimum)	54 units
Prerequisite	9 units
79-104 Introduction to World History (or equivalent as approved by the Department)	

Introductory Courses (2)	18 units
Complete two courses.	

79-206	Development of American Culture
79-207	Development of European Culture
79-253	Development of Caribbean Culture
79-258	Introduction to African History II: 18 th Century to Neo-Colonialism
79-270	Chinese Culture and Society
79-280	Russian History from First to Last Tsar
79-290	Between Revolutions: The Development of Modern Latin America
79-356	Introduction to African History I: Earliest Times to the Origins of the Slave Trade

Advanced Courses (4)	36 units
Complete four 200- or 300-level History courses	

Internship Program

The History Department offers internships (or supervised off-campus work experiences) designed for qualified junior and senior majors in History or Ethics, History, and Public Policy.

Undergraduate Research Fellow

Highly qualified history majors with prior research experience may apply to serve in their senior year as research fellows in one of the department's several research centers. Permission of Department Head is required.

Senior Thesis

Seniors may write a thesis with permission of the Director of Undergraduate Studies and a designated faculty member who will supervise its completion. By completing the thesis, the student earns 18 units of credit.

Senior Honors Thesis

The Honors Program provides recognition of outstanding performance by students in Social and Cultural History, History and Policy, and Anthropology and History, and the opportunity to carry this performance forward into a year-long senior honors thesis project. By completing the thesis, the student earns 18 units of credit and qualifies for graduation with College Honors. To qualify for the Honors Program, the student must have a cumulative QPA of at least 3.5 in the major and 3.25 overall by the end of the junior year, and must present a project proposal that is approved by a faculty sponsor who will serve as thesis advisor.

Study Abroad Program

In addition to Study Abroad Programs organized by the Office of International Education, the History Department, in conjunction with the Modern Languages Department, conducts short-term cultural studies abroad during Spring break. Study abroad not only helps History majors better understand the past, but also the relationship between cultural heritage and modern political processes in a host country. To make study abroad successful and to find how study abroad fits into requirements, History majors prepare study abroad proposals through close consultation with their history advisor.

Faculty

CAROLINE ACKER, Associate Professor of History — Ph.D., University of California, San Francisco; Carnegie Mellon, 1993—.

SUSAN AMBROSE, Teaching Professor of History; Director, The Eberly Center for Teaching Excellence — D.A., Carnegie Mellon University; Carnegie Mellon, 1986—.

JAY D. ARONSON, Assistant Professor of History — Ph.D., University of Minnesota; Carnegie Mellon, 2004—.

ALLYSON F. CREASMAN, Assistant Professor of History — Ph.D., University of Virginia; Carnegie Mellon, 2005—.

LAURIE Z. EISENBERG, Associate Teaching Professor of History — Ph.D., University of Michigan; Carnegie Mellon University, 1992—.

PAUL EISSL, Associate Professor of Anthropology and History — Ph.D. University of Michigan; Carnegie Mellon, 2000—.

EDDA FIELDS-BLACK, Associate Professor of History — Ph.D., University of Pennsylvania, Carnegie Mellon, 2001—.

WENDY Z. GOLDMAN, Professor of History; Director of Graduate Studies, Department of History — Ph.D., University of Pennsylvania; Carnegie Mellon, 1988—.

DONNA HARSCH, Professor of History — Ph.D., Yale University; Carnegie Mellon, 1990—.

DAVID A. HOUNSHELL, David M. Roderick Professor of Technology and Social Change — Ph.D., University of Delaware; Carnegie Mellon, 1991—.

KATHERINE A. LYNCH, Professor of History — Ph.D., Harvard University; Carnegie Mellon, 1980—.

RICHARD MADDUX, Professor of Anthropology and History — Ph.D., Stanford University; Carnegie Mellon, 1993—.

DAVID W. MILLER, Professor of History — Ph.D., University of Chicago; Carnegie Mellon, 1967—.

ROGER ROUSE, Associate Teaching Professor of History — Ph.D. Stanford University; Carnegie Mellon, 2006—.

SCOTT SANDAGE, Associate Professor of History; Director of Undergraduate Studies, Department of History — Ph.D. Rutgers University; Carnegie Mellon, 1995—.

JUDITH SCHACHTER, Professor of Anthropology and History — Ph.D., University of Minnesota; Carnegie Mellon, 1984—.

STEVEN SCHLOSSMAN, Professor of History — Ph.D. Columbia University; Carnegie Mellon 1988—.

JOHN SOLURI, Associate Professor of History — Ph.D. University of Michigan; Carnegie Mellon, 1999—.

DONALD S. SUTTON, Professor of History and Anthropology — Ph.D., Cambridge University, England; Carnegie Mellon, 1969—.

JOEL A. TARR, Richard S. Caliguiri University Professor — Ph.D., Northwestern University; Carnegie Mellon, 1967—.

LISA M. TETRAULT, Assistant Professor of History — Ph.D., University of Wisconsin; Carnegie Mellon, 2005—.

JOE WILLIAM TROTTER, Giant Eagle Professor of History and Social Justice; Head, Department of History — Ph.D., University of Minnesota; Carnegie Mellon, 1985—.

Adjunct Faculty

JOSEPH E. DEVINE, Adjunct Professor of History; Associate Dean, College of Humanities and Social Sciences — D.A., Carnegie Mellon University; Carnegie Mellon, 1979—.

NAUM KATS, Adjunct Professor of History — Ph.D., University of Saint Petersburg; Carnegie Mellon, 1990—.

MARIE NORMAN, Adjunct Professor of History — Ph.D., University of Pittsburgh; Carnegie Mellon, 1998—.

BENJAMIN REILLY, Visiting Assistant Professor of History — Ph.D., University of Pittsburgh; Carnegie Mellon, 2004—.

Department of Modern Languages

Susan G. Polansky, Department Head
Christian Hallstein, Director of Undergraduate Studies
Department Office: Baker Hall 160

The study of a foreign language is not only desirable but essential for successful integration into our current multinational, pluralistic world. If the United States is to achieve and maintain its respected leadership position in the world, it is incumbent upon us to educate citizens who will be sensitive to other cultures and capable of communicating in other languages. Proficiency in a foreign language by itself, or combined with other professional training, may lead to a variety of rewarding careers. Moreover, the personal experience of mastering another language is enriching and gratifying.

The Majors in Chinese, German, French & Francophone Studies, Hispanic Studies and Japanese

Modern Languages majors are available in Chinese, French & Francophone Studies, German, Hispanic Studies and Japanese as well as in European Studies and Russian Studies. These majors are designed to lead to acquisition of communicative language proficiency and substantive knowledge of other cultures.

Drawing on the unique interdisciplinary climate of the Carnegie Mellon campus, the undergraduate major in Modern Languages encourages the acquisition of multiple skills by students with varied backgrounds, talents and interests. An important resource in support of these goals is the Modern Language Resource Center, which is a state-of-the-art facility that provides students with access to authentic foreign language materials such as original television broadcasts, interactive video projects and computerized assessment tools.

Students majoring in a modern language are also encouraged to enroll, preferably during their junior year, in a study-abroad program or to spend a summer abroad at a language institute or in an internship. Semester or year-long programs are available in China, France, Germany, Japan, Africa, Russia, Spain and Latin America. The Department also sponsors summer language courses in China, France, Germany, Japan, Russia and Spain (see <http://ml.hss.cmu.edu/ml/>). Foreign film series, informal conversation tables, native-speaker conversation partners, writing assistants, and Student Advisory Committee cultural events are some of the activities organized by the Department of Modern Languages to increase students' ability in their chosen languages.

The major in Modern Languages is designed to permit students to acquire communicative language proficiency in their language of specialization. Courses in literature, culture and civilization offer students a solid introduction to the main currents in national literatures as well as artistic and social movements. These courses integrate study of target cultures with skill development in reading, writing, and aural/oral communication. In addition, the student who majors in Modern Languages will develop a perspective on the learning and use of second languages, from both a social and cognitive point of view, within contemporary American society and in an increasingly global community. Working closely with their advisor, language majors are guided to develop personal interests by taking courses in other disciplines such as fine arts, history, psychology, philosophy and English which often include readings, discussions and papers in the foreign language. The rich technological environment of the campus (computers, videodisks and satellite linkups) strongly enhances all fields of language study.

Second language proficiency is seen as an asset which enhances the study of all other fields and which will provide students with practical as well as theoretical bases for a variety of paths after graduation. Students will be prepared to pursue graduate studies in second language-related fields (e.g. linguistics, literature, second language acquisition) or they may use their undergraduate background as a complement to careers in fields such as the arts, government or public service, or volunteer work, technology, business and management, law and other areas in which proficiency in a second language is an asset.

Curriculum

Seven specializations are available to Modern Languages majors: Chinese, French and Francophone Studies, German, Hispanic Studies and Japanese as well as European Studies and Russian Studies.

Language-specific faculty advisors for these specializations are:

Faculty Advisors For Students in Majors

Yueming Yu, Associate Teaching Professor of Chinese	Chinese
Bonnie Youngs, Teaching Professor of French & Francophone Studies.....	French & Francophone Studies
Stephen Brockmann, Professor of German	German
Kenya C. Dworkin y Mendez, Associate Professor of Hispanic Studies	Hispanic Studies
Keiko Koda, Professor of Japanese & Second Language Acquisition, and	
Yasufumi Iwasaki, Assistant Teaching Professor of Japanese	Japanese
Beryl Schlossman, Professor of French & Francophone Studies	European Studies*
Charlene Castellano, Teaching Professor of Russian	Russian Studies*

* The majors in European Studies and Russian Studies are interdepartmental majors offered jointly with the Department of History. These majors are described in the H&SS Interdepartmental majors section of the catalog.

The Major in Chinese 96-99 units

Students who arrive at Carnegie Mellon with previous language study and/or who have high Advanced Placement, International Baccalaureate or internal placement exam scores will be able to begin taking courses toward the major earlier in their undergraduate program and will also be able, should they so desire, to complete an additional major. In all cases, progress toward the major will be accelerated by study abroad which is strongly recommended for all majors.

Prerequisites 0 - 36 units

Students need to complete Elementary Chinese I & II (82-131 & 82-132) and Intermediate Chinese I (82-231) courses, or Intensive Elementary Chinese (82-135). Exemption of these courses can be granted based on the result of the placement test administered by the program faculty.

1. Core Courses in Chinese 39 - 42 units*

Complete all four courses

82-232	Intermediate Chinese II**
82-331	Advanced Chinese I
82-332	Advanced Chinese II
82-333	Introduction to Chinese Language & Culture

*Placement out of 82-232 is possible. Students who place out of 82-232 will need to take one more course at the 300-level with a minimum of 9 units. Then the total credits for this category will be 39. The selection should be made between the following two courses based on the specific needs of each individual student:

82-335	Selected Readings in Chinese
82-337	Mandarin Chinese for Oral Communication

** This course may be substituted by 82-235 (Intensive Intermediate Chinese).

2. Core Courses in Modern Languages 12 units

(Complete one 9 unit course plus the Senior Seminar)

82-280	Learning about Language Learning
82-281	Tutoring for Community Outreach
82-358	Literacies Across Language and Culture
82-383	Introduction to Second Language Acquisition
82-388	Understanding Second Language Fluency
82-480	Social and Cognitive Aspects of Bilingualism
82-580	Senior Seminar

*In consultation with the Major Advisor, students may substitute a course related to language analysis from the listings in Chinese from another department. Examples: 80-180 Nature of Language, 80-181 Language and Thought, 85-421 Language and Thought

3. Core course(s) in History & Society (minimum) 9 units

Complete one of the following History courses after consultation with the Major Advisor and the designated History or Modern Languages professor.

79-270	Chinese Culture & Society
79-271	Modern China
79-293	20 th Century China Through Films

4. Chinese and Interdisciplinary Electives (minimum) 36 units

Complete two courses from List A and two courses from List B, or two courses from List A, one course from List B and one course from List C.

List A: Core Chinese Electives (minimum) 18 units

82-337	Mandarin Chinese for Oral Communication (I)
82-431	China and the West
82-432	Chinese Popular Culture
82-433	Topics on Contemporary Culture of China
82-434	Studies in Chinese Traditions
82-436	Introduction to Classical Chinese
82-439	Modern China Through Literature
82-531/532	Special Topics: Chinese*

List B: Chinese Electives (minimum) 9 units

82-334	Structure of Chinese
82-335	Selected Readings in Chinese
82-337	Mandarin Chinese for Oral Communication (I)
82-338	Mandarin Chinese for Oral Communication (II)
82-431	China and West
82-432	Chinese Popular Culture
82-439	Modern China through Literature
82-433	Topics on Contemporary Culture of China
82-434	Studies in Chinese Traditions*
82-436	Introduction to Classical Chinese
82-531/532	Special Topics Chinese

* Students may repeat with new topics.

List C: Interdisciplinary Electives 9 units

Students should consult OLR and their advisor for the most up to date interdisciplinary electives appropriate for the Chinese major curriculum. These electives should contain a component related to the Chinese major.

Architecture

48-351	Human Factors in Architecture
48-551	Ethics and Decision Making in Architecture

Art

60-373	Aesthetics from a Global Point of View
60-399	Art History/Theory Independent Study

Business

70-342	Managing across Cultures
70-365	International Trade and International Law
70-430	International Management

English

76-318	Communicating in the Global Marketplace
76-339	Advanced Studies in Film
76-350	Asian American Literature
76-386	Language and Culture
76-387	Sociolinguistics
76-442	Communication across Cultures

History

79-225	Religions of China
79-236	18 th Century China through Literature
79-270	Chinese Culture & Society
79-271	Modern China
79-293	20 th Century China Through Films

Modern Languages

82-280	Learning about Language Learning
82-281	Tutoring for Community Outreach
82-358	Literacies Across Language and Culture
82-383	Introduction to Second Language Acquisition
82-388	Understanding Second Language Fluency
82-480	Social and Cognitive Aspects of Bilingualism

Philosophy

80-180	The Nature of Language
80-181	Language and Thought
80-280	Linguistic Analysis
80-276	Philosophy of Religion
80-380	Philosophy of Language

Psychology

85-375	Cross Cultural Psychology
85-421	Language and Thought

Social and Decision Science

88-357	Comparative Foreign Policy: China, Russia and the US
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5. Additional Requirement**Oral Proficiency Interview**

Complete an oral proficiency interview. This test should be taken by the end of the first semester of the senior year; students are strongly encouraged to take it by the end of the junior year. Students are permitted to retake the test.

Study Abroad

A semester or year of study abroad or internship is strongly recommended.

Chinese (B.A.)**Sample Curriculum**

This sample curriculum assumes that all prerequisites for 82-331 are fulfilled prior to the Junior year.

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Advanced Chinese I 82-331	Advanced Chinese II 82-332	Core Chinese Elective List A	Core Chinese Elective List A
Introduction to Chinese Language and Culture 82-333	Core History Course	Chinese Elective List B or C	Chinese Elective List B
Core Modern Language Department Course	Elective	Elective	Senior Seminar 82-580
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years, not that it must be. Students may enter their major, and begin major course requirements as early as the start of the sophomore year, and in some instances, in the first year. Students should consult their advisor when planning their program.

This plan is an example of the suggested sequence of study for students who have had little or no prior exposure to the language. Such students would need to satisfy the prerequisites (elementary and intermediate level courses) during their freshman and sophomore years.

The Major in French and Francophone

Studies 93 units

Students who arrive at Carnegie Mellon with previous language study and/or have high Advanced Placement, International Baccalaureate or internal placement exam scores will be able to begin taking courses toward the major earlier in their undergraduate program and will also be able, should they so desire, to complete an additional major. In all cases, progress toward the major will be accelerated by study abroad which is strongly recommended for all majors.

Prerequisites 0 - 42 units

Intermediate level proficiency in the appropriate language. This is equivalent to the completion of four courses (two at the 100-level and two at the 200-level) or exemption based on Advanced Placement, International Baccalaureate or Carnegie Mellon internal placement test scores.

1. Core Courses in French and Francophone Studies 27 units

Complete all three courses.

82-303	French Culture
82-304	The Francophone World
82-305	French in its Social Contexts

2. Core Courses in Modern Languages 12 units

(Complete one 9 unit course* plus the Senior Seminar)

82-280	Learning about Language Learning
82-281	Tutoring for Community Outreach
82-358	Literacies Across Language and Culture
82-383	Introduction to Second Language Acquisition
82-388	Understanding Second Language Fluency
82-480	Social and Cognitive Aspects of Bilingualism
82-580	Senior Seminar (3 units)

*In consultation with the Major Advisor, students may substitute a course related to language analysis from the listings in French or from another department. Examples: 80-180 Nature of Language, 80-181 Language and Thought, 85-421 Language and Thought.

3. French and Francophone Studies Interdisciplinary Electives

Complete 45 units from List A and 9 units from List B.

List A. French and Francophone Electives

82-401	Francophone Popular Song
82-404	Francophone Realities: Africa
82-407	French Modernism: The Arts in Society
82-415/416	Topics in French and Francophone Studies
82-501/502	Special Topics: French
82-505	Undergraduate Internship

List B. Interdisciplinary Electives

Architecture

48-340	Modern Architecture and Theory: 1900-1945
48-341	History of Architectural Theory
48-445	The City in History
48-446	Renaissance and Baroque Architecture
48-448	History of Sustainable Architecture

English

76-385	Introduction to Discourse Analysis
76-386	Language and Culture
76-387	Introduction to Sociolinguistics

History

79-205	20th Century Europe: Collapse and Renewal
79-207	Development of European Culture
79-214	18 th Century European History
79-251	Flesh and Spirit: Early Modern Europe, 1400-1800
79-253	The Development of Caribbean Culture
79-258	Introduction to African History: 18 th Century Neo-Colonialism
79-275	Religious Identities and Religious Conflicts in 19 th Century Europe
79-294	The Making of the African Diaspora in the New World
79-307	The Anthropology of Europe
79-319	The City and the Country in Modern Europe
79-340	A History of Modern Warfare

79-350	Theories of International Relations
79-386	Music and Society in 19 th /20 th Century Europe and the U.S.

Modern Languages

82-281	Tutoring for Community Outreach
82-358	Literacies Across Language and Culture
82-380	Learning and Language Learning
82-383	Introduction to Second Language Acquisition
82-384	Language and Culture: Language in its Social Context
82-387	The Film Festival
82-388	Understanding Second Language Fluency
82-389	Independent Study in Language and Culture--Advanced Level
82-480	Social and Cognitive Aspects of Bilingualism
82-484	Language Assessment
82-487	Writing in a Second Language

Music

57-173	A Survey of Western Music History
57-285	History of Vocal Music
57-306	World Music
57-409	Puccini's Operas

Philosophy

80-180	The Nature of Language
80-280	Linguistic Analysis
80-281	Language and Thought
80-380	Philosophy of Language

Psychology

85-375	Cross Cultural Psychology
85-421	Language and Thought
85-455	Philosophy of Language

New courses will be added as appropriate.

4. Additional Requirement

Oral Proficiency Interview

Complete an oral proficiency interview with a Faculty member in French. This exam should be taken by the end of the first semester of the senior year; students are strongly encouraged to take it by the end of the junior year. Students are permitted to retake the exam.

Study Abroad

A semester or year of study abroad or internship is strongly recommended.

French and Francophone Studies (B.A.)

Sample Curriculum

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Introduction to French Culture 82-303	French in its Social Contexts 82-305	French Elective List A	French Elective List A
The Francophone World 82-304	French Elective List A	French Elective List A	French Elective List A
Learning about Language Learning 82-280	Interdisciplinary Elective List B	French Elective List A	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years, not that it must be. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the first year. Students should consult their advisor when planning their program.

The Major in German 93 units

Students who arrive at Carnegie Mellon with previous language study and/or who have high Advanced Placement, International Baccalaureate or internal placement exam scores will be able to begin taking courses toward the major earlier in their undergraduate program and will also be able, should they so desire, to complete an additional major. In all cases, progress toward the major will be accelerated by study abroad which is strongly recommended for all majors.

Prerequisites 0 - 42 units

Intermediate level proficiency in the appropriate language. This is equivalent to the completion of four courses (two at the 100-level and two at the 200-level) or exemption based on Advanced Placement, International Baccalaureate or Carnegie Mellon internal placement test scores.

1. Core Courses in German 27 units

Complete all three courses.

82-323 Germany, Austria, and Switzerland in the 20th Century
82-324 Contemporary Germany, Austria and Switzerland
82-325 Introduction to German Studies

* A 400-level course may be substituted with an advisor's approval.

2. Core Courses in Modern Languages 12 units

(Complete one 9 unit course* plus the Senior Seminar)

82-280 Learning about Language Learning
82-281 Tutoring for Community Outreach
82-358 Literacies Across Language and Culture
82-383 Introduction to Second Language Acquisition
82-388 Understanding Second Language Fluency
82-480 Social and Cognitive Aspects of Bilingualism
82-580 Senior Seminar (3 units)

*In consultation with the Major Advisor, students may substitute a course related to language analysis from the listings in German or from another department. Examples: 80-180 Nature of Language, 80-181 Language and Thought, 85-421 Language and Thought.

3. German and Interdisciplinary Electives 54 units

Complete 45 units from List A and 9 units from List B or 36 units from List A and 18 units from List B.

List A: German Electives

82-420 German Classical Literature
82-421 German Literature of the Nineteenth Century
82-422 German Literature of the Early Twentieth Century
82-423 Postwar German Literature
82-424 The New Germany
82-425/426 Studies in German Literature and Culture

82-427 Nazi and Resistance Culture
82-428 History of German Film
82-429 German Reading and Translation Workshop
82-521/522 Special Topics: German

List B: Interdisciplinary Electives

An additional elective(s), chosen in consultation with the Major Advisor, will be required of all students. The student may complete part of the course work in German (readings and written papers) with agreement of instructor.

English

76-239 Introduction to Film Studies
76-354 Contemporary Literary and Cultural Theory
76-386 Language and Culture
76-387 Introduction to Sociolinguistics
76-483 Cross Cultural Rhetoric

History

79-205 20th Century Europe:
79-219 The Holocaust in Historical Perspective
79-250 Two Revolutions: Dynamics of Change in Nineteenth Century Europe
79-307 The Anthropology of Europe

Modern Languages

82-280 Learning about Language Learning
82-281 Tutoring for Community Outreach
82-358 Literacies Across Language and Culture
82-383 Introduction to Second Language Acquisition
82-388 Understanding Second Language Fluency
82-480 Social and Cognitive Aspects of Bilingualism

Music

57-306 World Music

Philosophy

80-136 Social Structure, Public Policy and Ethical Dilemmas
80-151 God and the West
80-180 The Nature of Language
80-181 Language and Thought
80-251 Modern Philosophy
80-252 19th Century Philosophy
80-253 Continental Philosophy
80-256 Modern Moral Philosophy
80-260 Philosophy of Art
80-275 Metaphysics
80-279 Philosophy of Religion
80-280 Linguistic Analysis
80-380 Philosophy of Thought

Psychology

85-375 Cross Cultural Psychology
85-421 Language and Thought

Additional courses from other departments may be added to list as information becomes available.

4. Additional Requirement: Oral Proficiency Interview

Complete an oral proficiency interview. This test should be taken by the end of the first semester of the senior year; students are strongly encouraged to take it by the end of the junior year. Students are permitted to retake the test.

Study Abroad

A semester or year of study abroad or internship is strongly recommended.

German (B.A.)

Sample Curriculum

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Germany, Austria, and Switzerland in the 20th Century 82-323	Contemporary Germany, Austria and Switzerland 82-324	Introduction to German Studies 82-325	German Elective List A
German Elective List A	German Elective List A	German Elective List A	Required Elective List A or List B
Learning about Language Learning 82-280	Elective	Required Elective List A or List B	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective
			Senior Seminar 82-580

This is presented as a two-year plan (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years, not that it must be. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the first year. Students should consult their advisor when planning their program.

This plan is an example of the suggested sequence of study for students who have had little or no prior exposure to the language. Such students would need to satisfy the prerequisites (elementary and intermediate language study) during their freshman and sophomore years.

The Major in Hispanic Studies 93 units

Students who arrive at Carnegie Mellon with previous language study and/or who have high Advanced Placement, International Baccalaureate or internal placement exam scores will be able to begin taking courses toward the major earlier in their undergraduate program and will also be able, should they so desire, to complete an additional major. In all cases, progress toward the major will be accelerated by study abroad which is strongly recommended for all majors.

Prerequisites 0 - 42 units

Intermediate level proficiency in the appropriate language. This is equivalent to the completion of four courses (two at the 100-level and two at the 200-level) or exemption based on Advanced Placement, International Baccalaureate or Carnegie Mellon internal placement test scores.

1. Core Courses in Hispanic Studies 27 units

(Complete two courses.)

- 82-342 Spain: Language and Culture
- 82-343 Latin America: Language and Culture
- 82-344 U.S. Latinos: Language and Culture

Complete required course.

- 82-345 Introduction to Hispanic Literary and Cultural Studies

2. Core Courses in Modern Languages 12 units

(Complete one 9 unit course* plus the Senior Seminar)

- 82-280 Learning about Language Learning
- 82-281 Tutoring for Community Outreach
- 82-358 Literacies Across Language and Culture
- 82-383 Introduction to Second Language Acquisition
- 82-388 Understanding Second Language Fluency
- 82-480 Social and Cognitive Aspects of Bilingualism
- 82-580 Senior Seminar (3 units)

*In consultation with the Major Advisor, students may substitute a course related to language analysis from the listings in German or from another department. Examples: 80-180 Nature of Language, 80-181 Language and Thought, 85-421 Language and Thought.

3. Hispanic Studies and Interdisciplinary Electives 54 units

Complete 45 units from List A and 9 units from List B.

List A: Hispanic Studies Electives

- 82-441 Studies in Peninsular Literature and Culture*
- 82-442 Analysis of Spoken Spanish
- 82-443 Spanish Reading and Translation Workshop
- 82-444 The Structure of Spanish
- 82-445 U.S. Latino Literature: Necessity is the Mother of All 'Coyotes'
- 82-446 Political Drama of Spain
- 82-451 Studies in Latin American Literature and Culture*
- 82-452 The Latin American Fin de Siglo: Modernity, Modernismos and Underdevelopment
- 82-454 The Hispanic Caribbean: Rhyme, Reason and Song
- 82-455/456 Topics in Hispanic Studies*
- 82-457 Contemporary Latin American Texts: "Back to the Future" Revision, Rewriting, and Representation
- 82-541/542 Special Topics: Spanish

*Students may repeat these courses with new topics.

List B. Interdisciplinary Electives

From possibilities such as but not limited to the following, students should consult with the Major Advisor to identify an interdisciplinary elective to complement their program.

English

- 76-239 Introduction to Film Studies
- 76-354 Contemporary Literary and Cultural Theory
- 76-386 Language and Culture
- 76-387 Introduction to Sociolinguistics
- 76-483 Cross Cultural Rhetoric

History

- 79-250 Two Revolutions: Dynamics of Change in Nineteenth Century Europe
- 79-290 Modern Latin America, 1789 to the Present
- 79-292/82-452 The Latin America Fin de Siglo: Modernity, Modernismos and Underdevelopment
- 79-307 The Anthropology of Europe
- 79-325 Art and Religion

Modern Languages

- 82-383 Introduction to Second Language Acquisition
- 82-480 Social and Cognitive Aspects of Bilingualism

Music

- 57-321 World Music

Philosophy

- 80-180 The Nature of Language
- 80-181 Language and Thought
- 80-280 Linguistic Analysis
- 82-380 Philosophy of Language

Psychology

- 85-375 Cross Cultural Psychology
- 85-421 Language and Thought

4. Additional Requirement

Oral Proficiency Interview

Complete the oral proficiency interview. This test should be taken by the end of the first semester of the senior year; students are strongly encouraged to take it by the end of the junior year. Students are permitted to retake the test.

Study Abroad

A semester or year of study abroad or internship is strongly suggested.

Hispanic Studies (B.A.)

Sample Curriculum

This sample curriculum assumes that all prerequisites for 82-371 are fulfilled prior to the Junior year.

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Spain Language and Culture 82-342	Introduction to Hispanic Literary and Cultural Studies 82-345	Spanish Elective List A	Spanish Elective List A
Latin America or U.S. Latinos Language and Culture 82-343/82-344	Interdisciplinary Elective List B	Spanish Elective List A	Spanish Elective List A
Learning about Language Learning 82-280	Elective	Spanish or Interdisciplinary Elective List A or List B	Senior Seminar 82-580 Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective
			Elective

This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years, not that it must be. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the first year. Students should consult their advisor when planning their program.

This plan is an example of the suggested sequence of study for students who have had little or no prior exposure to the language. Such students would need to satisfy the prerequisites (elementary and intermediate language study) during their freshman and sophomore years.

The Major in Japanese 102–105 units

Students who arrive at Carnegie Mellon with previous language study and/or who have high Advanced Placement, International Baccalaureate or internal placement exam scores will be able to begin taking courses toward the major earlier in their undergraduate program and will also be able, should they so desire, to complete an additional major. In all cases, progress toward the major will be accelerated by study abroad which is strongly recommended for all majors.

Prerequisites 0–36 units

Low-intermediate level proficiency in Japanese. This is equivalent to the completion of three courses (two at the 100-level and one at the 200-level) or exemption based on internal placement test scores.

1. Core Courses in Japanese 27–39 units*

Complete all four courses.

82-272	Intermediate Japanese II*
82-273	Introduction to Japanese Language and Culture
82-371	Advanced Japanese I
82-372	Advanced Japanese II

*Placement out of 82-272 is possible. For students who place out of 82-272, a minimum of 9 additional units must be taken from Category 2 or 4 below.

2. Core Courses in Modern Languages 12 units

(Complete one 9 unit course plus the Senior Seminar)

82-280	Learning about Language Learning
82-281	Tutoring for Community Outreach
82-358	Literacies Across Language and Cultures
82-383	Introduction to Second Language Acquisition
82-388	Understanding Second Language Fluency
82-480	Social and Cognitive Aspects of Bilingualism
82-580	Senior Seminar (3 units)

3. Core Course(s) in History* (minimum) 9 units

Complete one of the following History courses in consultation with the Major Advisor and the designated History or Modern Languages professor.

79-200	Historical Evidence and Interpretation
79-201	Introduction to Anthropology
79-259	Introduction to Religion
79-298	Sex and Gender (in Anthropological Perspective)
79-380	Experiencing Globalization

*Majors are encouraged to complete at least one more History course focusing on Japanese history in fulfillment of the major requirement. This list will evolve according to the current offerings of the Departments of History and Modern Languages.

4. Japanese and Interdisciplinary Electives (minimum) 45 units

(Complete five courses from List A or a minimum of three courses from List A and one or two courses from List B in consultation with the Major Advisor.

List A: Japanese Electives

82-473/474	Topics in Japanese Studies*
82-476	Japanese Discount Analysis
82-571/572	Special Topics: Japanese

*Students may repeat with new topics.

List B: Interdisciplinary Electives

An additional elective(s), chosen in consultation with the Major Advisor, will be required of all students. The student may be required to complete part of the course work in Japanese.

English

76-239	Introduction to Film Studies
76-354	Contemporary Literary and Cultural Theory
76-386	Language and Culture
76-387	Introduction to Sociolinguistics

History

79-200	Historical Evidence and Interpretation
79-201	Introduction to Anthropology
79-225	Religions of China
79-259	Introduction to Religion
79-298	Sex and Gender (in Anthropological Perspective)
79-380	Experiencing Globalization

Modern Languages

82-278	Japanese Literature in Translation
82-280	Learning About Language Learning
82-281	Tutoring for Community Outreach
82-358	Literacies Across Language and Culture
82-373	Structure of the Japanese Language
82-374	Technical Japanese
82-383	Introduction to Second Language Acquisition
82-388	Understanding Second Language Fluency
82-480	Social and Cognitive Aspects of Bilingualism

Music

57-306	World Music
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Philosophy

80-180	The Nature of Language
80-181	Language and Thought
80-280	Linguistic Analysis
80-380	Philosophy of Language

Psychology

85-375	Cross Cultural Psychology
85-421	Language and Thought

4. Additional Requirement

Oral Proficiency Interview

Complete an oral proficiency interview. This test should be taken by the end of the first semester of the senior year; students are strongly encouraged to take it by the end of the junior year. Students are permitted to retake the test.

Study Abroad

A semester or year of study abroad or internship is strongly recommended.

Japanese (B.A.)

Sample Curriculum

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Introduction to Japanese Language and Culture 82-273	Core History Course	Required Elective List A	Required Elective List A
Advanced Japanese I	Advanced Japanese II	Required Elective List A	Required Elective List B
Learning about Language Learning 82-280	Elective	Elective/ Required Elective List B	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective
			Senior Seminar 82-580

This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years, not that it must be. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the first year. Students should consult their advisor when planning their program.

This plan is an example of the suggested sequence of study for students who have had little or no prior exposure to the language. Such students would need to satisfy the prerequisites (elementary and intermediate language study) during their freshman and sophomore years.

Additional Major

H&SS students as well as students from other colleges may complete an additional major in Chinese, French, German, Hispanic Studies or Japanese by completing the major requirements as outlined above in addition to the requirements for their primary major. Non-H&SS students interested in an additional major in Modern Languages need to fulfill only the requirements for the chosen Modern Languages major but not the H&SS General Education program requirements.

Minors in the Department of Modern Languages

In addition to the majors in the Department of Modern Languages with specializations in English as a Second Language (ESL), European Studies, French and Francophone Studies, German, Hispanic Studies, Japanese, or Russian Studies, it is also possible to minor in Chinese, European Studies, French, German, Hispanic Studies, Japanese, and Russian Studies.

For the student who has chosen to major in another discipline, a minor in one of these languages is an asset which enhances almost any other field of study. The minor in Modern Languages permits students to acquire similar levels of communicative language proficiency as do students who major in the language but requires fewer courses in complementary areas.

Language-specific faculty advisors for these specializations are:

Faculty Advisors For Students in Minors

- Yueming Yu,**
Associate Teaching Professor of Chinese Chinese
- Bonnie Youngs,**
Teaching Professor of French & Francophone Studies..... French & Francophone Studies
- Christine Hallstein,**
Teaching Professor of German German
- Therese Tardio,**
Associate Teaching Professor of Hispanic Studies .. Hispanic Studies
- Sono Takano Hayes,**
Associate Teaching Professor of Japanese, and
- Yasufumi Iwasaki,**
Assistant Teaching Professor of Japanese Japanese
- Beryl Schlossman,**
Professor of French & Francophone Studies European Studies*
- Charlene Castellano,**
Teaching Professor of RussianRussian Studies*

*The minors in European Studies and Russian Studies are interdepartmental minors offered jointly with the Department of History. These minors are described in the H&SS Interdepartmental minors section of the catalog.

Curricula

The minimum requirement for the minor in French, German or Hispanic Studies is 54 units (not including any 100- or 200-level prerequisite work in the chosen language), as outlined below. The minimum requirement for the minor in Chinese or Japanese is 54-60 units, depending on the student's point of entry.

The Minor in Chinese 57-60 units

Prerequisites 0 - 36 units

Completion of Elementary Chinese I and II and Intermediate Chinese I at Carnegie Mellon University (with a minimum grade of "B") or equivalent (based on a placement test).

1. Core Courses in Chinese 39 units

Complete four courses.

- 82-232 *Intermediate Chinese II
- 82-235 *Intensive Intermediate Chinese
- 82-331 Advanced Chinese I
- 82-332 Advanced Chinese II
- 82-333 Introduction to Chinese Language and Culture

*82-235 Intermediate-level Chinese course may be substituted for 82-232.

Students who place out of an Intermediate-level Chinese course will need to take an additional 300-level, 9-unit course. Then the total units for this category will be 39 units. Students must choose from the following two courses based on specific needs of each individual student:

- 82-335 Selected Readings in Chinese
- 82-337 Mandarin Chinese for Oral Communication

2. Chinese and Interdisciplinary Electives 18 units**List A. Chinese Electives**

Complete one or two courses after consultation with the Minor Advisor. Students may select another course in this category to substitute for the Interdisciplinary Elective.

82-334	Structure of Chinese
82-335	Selected Readings in Chinese
82-337	Mandarin Chinese for Oral Communication I
82-338	Mandarin Chinese for Oral Communication II
82-431	China and the West
82-432	Chinese Popular Culture
82-433	Topics in Contemporary Culture of China
82-434	Studies in Chinese Traditions
82-436	Introduction to Classical Chinese
82-439	Modern China Through Literature

List B. Interdisciplinary Elective (minimum) 9 units

Complete one course. Students may select another course in this category to substitute for the Core Elective.

79-225	Religions of Asia
79-236	18 th Century China Through Literature
79-270	Chinese Culture and Society
79-271	Modern China
79-293	20 th Century China Through Literature
82-280	Learning about Language Learning
82-281	Tutoring for Community Outreach
82-358	Literacies Across Language and Culture
82-383	Introduction to Second Language Acquisition
82-387	The Film Festival*
82-388	Understanding Second Language Fluency
82-480	Social and Cognitive Aspects of Bilingualism

New courses will be added as appropriate.

* This course is counted only when it has a China-related topic

The Minor in French and Francophone Studies 54 units**Prerequisites** 0-42 units

Intermediate level proficiency in the French language. Students who arrive at Carnegie Mellon with previous language study and/or who have high Advanced Placement, International Baccalaureate or internal placement exam scores will be able to begin taking courses toward the minor earlier in their undergraduate. Study abroad is strongly recommended.

1. Core Courses in French and Francophone Studies 27 units

Complete three courses.

82-303	French Culture
82-304	The Francophone World
82-305	French in its Social Contexts

2. French and Francophone Studies and Interdisciplinary Electives 27 units

Complete 27 units from List A or 18 units from List A and 9 units from List B, with advisor's approval.

List A. French Electives

82-401	Francophone Popular Song
82-404	Francophone Realities Africa
82-407	French Modernism: The Arts in Society
82-415/416	Topics in French and Francophone Studies
82-501/502	Special Topics: French
82-505	Undergraduate Internship

List B. Interdisciplinary Electives**Architecture**

48-342	Modern Architecture and Theory: 1900-1945
48-343	History of Architectural Theory
48-445	The City in History
48-446	Renaissance and Baroque Architecture
48-448	History of Sustainable Architecture

English

76-385	Introduction to Discourse Analysis
76-386	Language and Culture
76-387	Introduction to Sociolinguistics

History

79-205	20th Century Europe
79-207	Development of European Culture
79-214	18 th Century European History
79-251	Flesh and Spirit: Early Modern Europe, 1400-1800
79-253	The Development of Caribbean Culture
79-258	Introduction to African History: 18 th Century Neo-Colonialism
79-275	Religious Identities and Religious Conflicts in 19 th Century Europe
79-294	The Making of the African Diaspora in the New World
79-307	The Anthropology of Europe
79-340	A History of Modern Warfare
79-350	Theories of International Relations
79-386	Music and Society in 19 th /20 th Century Europe and the U.S.

Modern Languages

82-281	Tutoring for Community Outreach
82-358	Literacies Across Language and Culture
82-380	Learning and Language Learning
82-383	Introduction to Second Language Acquisition
82-384	Language and Culture: Language in it's Social Context
82-387	The Film Festival
82-388	Understanding Second Language Fluency
82-389	Independent Study in Language and Culture – Advanced Level
82-480	Social and Cognitive Aspects of Bilingualism
82-484	Language Assessment
82-487	Writing in a Second Language

Music

57-173	A Survey of Western Music History
57-285	History of Vocal Music
57-306	World Music
57-409	Puccini's Operas

Philosophy

80-180	The Nature of Language
80-280	Linguistic Analysis
80-281	Language and Thought
80-380	Philosophy of Language

Psychology

85-375	Cross Cultural Psychology
85-421	Language and Thought
85-455	Philosophy of Language

New courses will be added as appropriate

The Minor in German 54 units**Prerequisites** 0 - 42 units

Intermediate level proficiency in the German language. Students who arrive at Carnegie Mellon with previous language study and/or who have high Advanced Placement, International Baccalaureate or internal placement exam scores will be able to begin taking courses toward the minor earlier in their undergraduate program. Study abroad is strongly recommended.

1. Core Courses in German 27 units

Complete three courses.

82-323	Germany, Austria and Switzerland in the 20th Century*
82-324	Contemporary Germany, Austria, and Switzerland*
82-325	Introduction to German Studies

* A 400-level course may be substituted with an advisor's approval.

2. German & Interdisciplinary Electives 27 units

Complete 27 units from List A.(400 level German courses) or 18 units from List A and 9 units from List B, with advisors approval.

List A. German Electives

82-420	German Classical Literature
82-421	German Literature of the Nineteenth Century
82-422	German Literature of the Early Twentieth Century
82-423	Postwar German Literature
82-424	The New Germany
82-425/426	Studies in German Literature and Culture
82-427	Nazi and Resistance Culture
82-428	History of German Film
82-429	German Reading and Translation Workshop
82-521/522	Special Topics: German

List B. Interdisciplinary Electives

English

76-239	Introduction to Film Studies
76-354	Contemporary Literary and Cultural Studies
76-386	Language and Culture
76-387	Introduction to Sociolinguistics
76-483	Cross Cultural Rhetoric

History

79-205	20th Century Europe
79-219	The Holocaust in Historical Perspective
79-250	Two Revolutions: Dynamics of Change in Nineteenth Century Europe
79-307	The Anthropology of Europe

Modern Languages

82-280	Learning About Language Learning
82-281	Tutoring for Community Outreach
82-358	Literacies Across Language and Culture
82-383	Introduction to Second Language Acquisition
82-388	Understanding Second Language Fluency
82-480	Social and Cognitive Aspects of Bilingualism
82-387	Film Festival (When offered by German Professor with German Topics)

Music

57-306	World Music
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Philosophy

80-136	Social Structures, Public Policy and Ethical Dilemmas
80-151	God and the West
80-180	The Nature of Thought
80-181	Language and Thought
80-251	Modern Philosophy
80-252	19th Century Philosophy
80-253	Continental Philosophy
80-256	Modern Moral Philosophy
80-260	Philosophy of Art
80-275	Metaphysics
80-279	Philosophy of Religion
80-280	Linguistic Analysis
80-380	Philosophy of Language

Psychology

85-375	Cross Cultural Psychology
85-421	Language and Thought

Additional courses from other departments may be added to list as information becomes available.

The Minor in Hispanic Studies 54 units

Prerequisites 0-42 units

Intermediate level proficiency in the appropriate language. Students who arrive at Carnegie Mellon with the previous language study and/or who have high Advancement Placement, International Baccalaureate or internal placement exam scores will be able to begin taking courses toward the major earlier in their undergraduate program. Study abroad is strongly recommended.

1. Core Courses in Hispanic Studies

Complete two courses.

82-342	Spain: Language and Culture
82-343	Latin America: Language and Culture
82-344	U.S. Latinos: Language and Culture

Complete two courses.

82-345	Introduction to Hispanic Literary and Cultural Studies
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2. Hispanic and Interdisciplinary 27 units

After consultation with the Minor Advisor, complete 3 courses (27 units) from List A or 2 courses (18 units) from List A and one course (9 units) from List B.

List A: Hispanic Electives

82-441	Studies in Peninsular Literature and Culture*
82-442	Analysis of Spoken Spanish
82-443	Spanish Reading and Translation Workshop
82-444	The Structure of Spanish
82-445	U.S. Latino Literature: Necessity is the Mother of All "Coyotes"
82-446	Political Drama of Spain
82-451	Studies in Latin American Literature and Culture *
82-452	Modernisms and Underdevelopment
82-454	The Hispanic Caribbean: Rhyme, Reason and Song
82-455/456	Topics in Hispanic Studies*
82-457	Contemporary Latin American Texts: "Back to the Future"- Revision, Rewriting, and Representation
82-541/542	Special Topics: Spanish

* Students may repeat these courses with new topics.

List B. Interdisciplinary Electives

From possibilities such as but not limited to the following, students should consult with the Major Advisor to identify an interdisciplinary elective to complement their program.

English

76-239	Introduction to Film Studies
76-354	Contemporary Literary and Cultural Theory
76-386	Language and Culture
76-387	Introduction to Sociolinguistics

History

79-250	Two Revolutions: Dynamics of Change in Nineteenth Century Europe
79-290	Modern Latin America, 1789 to the Present
82-452	The Latin American Fin de Siglo: Modernity, Modernisms and Underdevelopment
79-307	The Anthropology of Europe
79-325	Art and Religion

Modern Languages

82-280	Learning About Language Learning
82-281	Tutoring for Community Outreach
82-358	Literacies Across Language and Culture
82-383	Introduction to Second Language Acquisition
82-388	Understanding Second Language Fluency
82-480	Social and Cognitive Aspects of Bilingualism

Music

57-306	World Music
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Philosophy

80-180	The Nature of Language and Thought
80-181	Language and Thought
80-280	Linguistic Analysis
80-380	Philosophy of Languages

Psychology

85-375	Cross Cultural Psychology
85-421	Language and Thought

The Minor in Japanese 54-57 units

Prerequisites 0-36 units

Low intermediate-level proficiency in the Japanese language. Students who arrive at Carnegie Mellon with previous language study and/or who have high Advancement Placement, International Baccalaureate or internal placement exam scores will be able to begin taking course toward the minor earlier in their undergraduate program. Study abroad is strongly recommended.

1. Core Courses in Japanese 27-39 units*

Complete four courses.

82-272	Intermediate Japanese II*
82-273	Introduction to Japanese Language and Culture
82-371	Advanced Japanese I
82-372	Advanced Japanese II

*Placement out of 82-272 is possible. For students who place out of 82-272 a minimum of 12 additional units may be taken from category 2 below.

2. Japanese and Interdisciplinary Electives 18 units

In consultation with the Minor Advisor, complete two courses from List A, or one course from List A and one course from List B.

List A. Japanese Electives

82-373	Structure of the Japanese Language
82-374	Technical Japanese
82-378	Japanese Conversation Analysis
82-473/474	Topics in Japanese Studies*
82-476	Japanese Discourse Analysis
82-571/572	Special Topics: Japanese

*Students may repeat with new topics

List B. Interdisciplinary Electives

English

76-239	Introduction to Film Studies
76-354	Contemporary Literary and Cultural Theory
76-386	Language and Culture
76-387	Introduction to Sociolinguistics

History

79-200	Historical Evidence and Interpretation
79-201	Introduction to Anthropology
79-225	Religions of China
79-259	Introduction to Religion
79-298	Sex and Gender (in Anthropological Perspective)
79-380	Experiencing Globalization

Modern Languages

82-278	Japanese Literature in Translation
82-280	Learning About Language Learning
82-281	Tutoring for Community Outreach
82-358	Literacies Across Language and Culture
82-383	Introduction to Second Language Acquisition
82-388	Understanding Second Language Fluency
82-480	Social and Cognitive Aspects of Bilingualism

Music

57-306	World Music
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Philosophy

80-180	Nature of Language
80-181	Language and Thought
80-280	Linguistic Analysis
80-380	Philosophy of Language

Psychology

85-375	Cross Cultural Psychology
85-421	Language and Thought

New courses will be added as appropriate.

Faculty

MARIANA ACHUGAR, Associate Professor of Spanish & Second Language Acquisition — Ph.D., University of California at Davis; Carnegie Mellon University, 2003—.

STEPHEN BROCKMANN, Professor of German with courtesy appointments in English and History — Ph.D., University of Wisconsin-Madison; Carnegie Mellon University, 1993—.

CHARLENE CASTELLANO, Teaching Professor of Russian with a courtesy appointment in English — Ph.D., Cornell University; Carnegie Mellon University, 1990—.

KENYA C. DWORKIN Y MENDEZ, Associate Professor of Spanish with courtesy appointments in English and History — Ph.D., University of California, Berkeley; Carnegie Mellon University, 1993—.

GABRIEL EICHMANNS, Assistant Teaching Professor of German — Ph.D., University of Washington; Carnegie Mellon, 2008—.

MICHEL FOUGERES, Associate Professor Emeritus of French — Ph.D., New York University; Carnegie Mellon University, 1969—.

BARBARA FREED, Professor of French and Second Language Acquisition — Ph.D., University of Pennsylvania; Carnegie Mellon University, 1990—.

FELIPE GOMEZ, Assistant Teaching Professor of Spanish — Ph.D., University of Illinois at Urbana-Champaign; Carnegie Mellon University, 2006—.

CHRISTIAN HALLSTEIN, Director of Undergraduate Studies — Ph.D., Pennsylvania State University; Carnegie Mellon University, 1979—.

PAUL HOPPER, Paul Mellon Distinguished Professor of the Humanities, Rhetoric and Linguistics with a courtesy appointment in Modern Languages — Ph.D., University of Texas; Carnegie Mellon, 1990—.

SONO TAKANO HAYES, Associate Teaching Professor of Japanese — Ph.D., University of Michigan; Carnegie Mellon University, 1987—.

YASUFUMI IWASAKI, Assistant Teaching Professor of Japanese — Ph.D., University of Illinois; Carnegie Mellon, 2005—.

BARBARA JOHNSTONE, Professor of Rhetoric and Linguistics with a courtesy appointment in Modern Languages — Ph.D., University of Michigan; Carnegie Mellon, 1997—.

CHRISTOPHER M. JONES, Director of the Modern Language Resource Center and Teaching Professor of French — Ph.D., University of Massachusetts, Amherst; Carnegie Mellon University, 1993—.

XIAOFEI KANG, Associate Professor of Chinese, —Ph.D. Columbia University; Carnegie Mellon University, 2006—.

KEIKO KODA, Professor of Japanese and Second Language Acquisition, Director of Graduate Studies — Ph.D., University of Illinois at Urbana-Champaign; Carnegie Mellon University, 1995—.

BRIAN MACWHINNEY, Professor of Psychology with a courtesy appointment in Modern Languages — Ph.D., University of California, Berkeley; Carnegie Mellon University, 1981—.

SUSAN G. POLANSKY, Teaching Professor of Spanish, Head of Modern Languages — Ph.D., Boston College; Carnegie Mellon University, 1986—.

GIOVANNI PUPPO, Instructor of Italian — Ph.D., University of Rome; Carnegie Mellon University, 1975—.

CARRIE RUIZ, Assistant Professor of Hispanic Studies — Ph.D., University of Colorado; Carnegie Mellon, 2008—.

BERYL SCHLOSSMAN, Professor of French and Francophone Studies and European Studies with a courtesy appointment in English — Ph.D., Université de Paris; Ph.D., Johns Hopkins University; Carnegie Mellon University, 1993—.

JURIS SILENIEKS, Professor Emeritus of French — Ph.D., University of Nebraska; Carnegie Mellon University, 1960—.

NAOKO TAGUCHI, Assistant Professor of Japanese & Second Language Acquisition—Ph.D., Northern Arizona University; Carnegie Mellon University, 2005—.

THERESE TARDIO, Lecturer in Spanish — Ph.D. University of Pittsburgh; Carnegie Mellon University, 2001—.

G. RICHARD TUCKER, Paul Mellon University Professor of Applied Linguistics, Interim Dean of Student Affairs with a courtesy appointment in Psychology — Ph.D., McGill University; Carnegie Mellon University, 1992—.

JAN VAIRO, Instructor of Italian — M.A., University of Pittsburgh; Carnegie Mellon University, 1992—.

JING WANG, Assistant Teaching Professor of Japanese — Ph.D. (ABD), University of Wisconsin; Carnegie Mellon, 2008—.

MICHAEL J. WEST, Teaching Professor of French — Ph.D., University of California, Santa Barbara; Carnegie Mellon University, 1989—.

DANIELLE WETZEL, — Assistant Teaching Professor and Director of First Year English with a courtesy appointment in Modern Languages — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2006—.

SUE-MEI WU, Associate Teaching Professor of Chinese —Ph.D., Ohio State University; Carnegie Mellon University, 2000—.

BONNIE L. YOUNGS, Teaching Professor of French — Ph.D., University of Pennsylvania; Carnegie Mellon University, 1993—.

YUEMING YU, Associate Teaching Professor of Chinese — Ed.D., University of Pittsburgh; Carnegie Mellon University, 1992—.

Department of Philosophy

Richard Scheines, Department Head
Office: Baker Hall 135

The Department of Philosophy was founded in 1985 and reflects the tradition of philosophy as a central discipline in the humanities. The department has achieved an international reputation through the acclaimed research of its members and its innovative educational programs, not only in traditional topics such as ethics, philosophy of mind, logic, and theory of knowledge, but in such contemporary and applied areas as automated theorem proving, machine learning, the foundations of statistics, causal discovery, forward learning theory, game and decision theory, conflict resolution, and business ethics.

Philosophy thrives through contact with other disciplines. Interdisciplinary work, a traditional strength of the Carnegie Mellon community, is vital to the department and is reflected in the courses we offer, many of which incorporate substantive material from a range of other disciplines. Some courses are actually team-taught with professors from other departments and schools around the university.

Our programs are designed to develop our students' analytical sophistication and their practical and theoretical skills in specializations outside the department (see the sample curricula below). The department welcomes and, indeed, encourages minors and additional majors from other disciplines who are interested in reflecting on the foundation of their own subjects. The department offers two different undergraduate major programs, and jointly sponsors two interdepartmental majors: Ethics, History, and Public Policy (with the Department of History), and Linguistics (with English, Modern Languages, and Psychology):

- the B.A. or B.S. in Ethics, History, and Public Policy (interdisciplinary major with Department of History)
- the B.S. in Logic and Computation
- the B.A. in Philosophy
- the B.A. in Linguistics (interdisciplinary major with Departments of English, Modern Languages, and Psychology)

The major in Logic and Computation is perhaps the most non-traditional of the department's majors. It offers students a firm background in computer science, together with a solid grounding in logic, philosophy, and mathematics. This reflects the department's commitment to the use of formal, analytic methods in addressing philosophical issues. A flexible system of electives allows students to focus their efforts in any of a wide range of disciplines, from engineering to the fine arts. As a capstone to the program, students engage in original research in their senior year, and write a thesis under the direction of an advisor.

The department also sponsors four minor programs:

- the minor in Ethics
- the minor in Linguistics
- the minor in Logic and Computation
- the minor in Philosophy

Finally, the department offers two master's programs directly extending the departmental majors. Both programs are coordinated with and build on the undergraduate programs, so that majors can complete the requirements for the master's degree in one additional year:

- the M.S. in Logic and Computation
- the M.A. in Philosophy

Students who choose the appropriate specialized track in the Logic and Computation major (namely, sample 2 of the Curricula listed below) can be admitted to the M.S. program in Language and Information Technology offered by the School of Computer Science. To complete the discussion of departmental programs, it should be mentioned that the department sponsors as part of the Program in Pure and Applied Logic (offered jointly with the Departments of Computer Science and Mathematics) a Ph.D. in Logic, Computation, and Methodology.

The Major in Ethics, History, and Public Policy

Andy Norman, Undergraduate Advisor

This is an interdepartmental major that is jointly sponsored by the Departments of History and of Philosophy. Preparing students for leadership positions is a vital goal of colleges and universities in every democratic and technologically advanced society. The intellectual challenges facing public and private sector leaders expand dramatically each year, and there is a compelling need in twenty-first-century America for broadly educated, ethically sensitive, and technically skilled public servants. They will have to demonstrate sophisticated interdisciplinary knowledge, deep understanding of how modern-day problems have evolved, and clear, rational criteria for ethical decision-making. The major in Ethics, History, and Public Policy seeks to provide students with a solid humanistic foundation for developing such high-level leadership capabilities. It also provides ample room for specialization, technical skill development, and internship experience in a wide range of policy areas. For a detailed discussion of the curriculum and the flexible tracks, consult the H&SS Interdepartmental Majors section of the catalog.

The Major in Linguistics

Mandy Simons, Director

Linguistics is the study of human language, and encompasses a broad spectrum of research questions, approaches, and methodologies. Some linguists are concerned with the cognitive aspects of language learning, production, and comprehension; some are concerned with language as a social and cultural phenomenon; others engage in the analysis of linguistic form and meaning, some from a functional and others from a formal perspective. There are also computational approaches to linguistics with both applied and theoretical goals.

The Major in Linguistics reflects the multidisciplinary character of the field and of the Linguistics faculty here at Carnegie Mellon, combining course offerings from the departments of English, Modern Languages, Philosophy, Psychology, and the Language Technologies Institute. The program provides students with the fundamental tools of linguistic analysis while maintaining a focus on the human context in which language is learned and used. After completing their core courses, students can follow a concentration in one of three areas: Language in its Social Context, Language and Mind, or Language and Communication. Various specialized electives, including Language Technology courses, are available to students with the appropriate preparation. Students can choose to focus fairly narrowly on an area of particular interest, or to explore it more widely.

The Major in Linguistics is available as either a primary major or an additional major. It is an ideal choice for students with a general interest in their own or other languages, and combines well thematically with studies in any of the departments represented in the major. For a detailed discussion of the curriculum and the flexible tracks, consult the H&SS Interdepartmental Majors section of the catalog.

The Major in Logic and Computation

Horacio Arlo-Costa, Director

The Logic and Computation curriculum takes advantage of the preparation provided by the H&SS General Education Program in mathematics, philosophy, psychology, and statistics. It is flexible in that it permits students to focus on any of a number of areas including (but not limited to):

- computer science;
- language and information technology;
- artificial intelligence and cognitive science;
- logic and the foundations of mathematics;
- methodology and philosophy of science.

Students in the program take a common core of courses in logic, methodology, and computer science, together with an associated seminar in their senior year. The individual focus is achieved by selecting a sequence of four advanced and closely related courses. It is in this area of focus (or specialization) that students write their senior thesis under the supervision of a faculty member. A number of sample curricula are presented below.

The resulting education in logic, analytic philosophy, mathematics, statistics, and computer science enables students to pursue professional careers or graduate study. The analytic and communication skills developed in the major support a wide range of career choices, including those among the fields of technology, business, and law. Fields of graduate study for which students are well prepared include, for example, computer science, cognitive science, philosophy, logic, and linguistics.

Students who are interested in pursuing this major, or who are pursuing it already, should take note of the Cognitive Science major in the Department of Psychology. That major is so closely related that it is not difficult to pursue it as an additional major, and it provides an intellectually exciting complement.

Curriculum

Logic and Computation is a B.S. degree. In their freshman and sophomore years, students are expected to take four courses that provide preparation in logic, computer science, mathematics, and statistics: Programming Fundamentals (15-111), Concepts of Mathematics (21-127), Statistical Reasoning (36-201), Arguments and Mathematical Inquiry (80-211). This last course is already part of the major's Core Requirements, but should be taken no later than the spring of the sophomore year. This also applies to the computer science sequence 15-211/212.

NOTE: Students should complete the prerequisites before their junior year. It is strongly recommended that students take Arguments and Mathematical Inquiry no later than the spring of their sophomore year and, if possible, also Fundamental Data Structures and Algorithms and Principles of Programming. However, with suitable planning and advice from the program director, it is possible to complete the program in two years, beginning in the junior year.

The course requirements for the major consist of six core courses, four electives, and one seminar. The core courses provide comprehensive background in logic, computability, and analytic philosophy. Logic and Computation (80-310) and Minds, Machines, and Knowledge (80-300) must be taken no later than the fall of the junior year. Four advanced electives are chosen in the area of focus, and should support independent research towards fulfilling the senior thesis requirement. In their senior year, students present and discuss their research in the thesis seminar.

Prerequisites	28 units*
15-111	Intermediate/Advanced Programming (10 units)
or	
15-200	Advanced Programming/Practicum
21-127	Concepts of Mathematics
36-201	Statistical Reasoning

Logic and Computation Core	69 units*
80-211	Arguments and Mathematical Inquiry
80-300	Minds, Machines, and Knowledge
80-310	Logic and Computation
80-311	Computability and Incompleteness
80-511	Thesis seminar
15-211	Fundamental Data Structures and Algorithms
15-212	Principles of Programming

*Only 45 units are unique to the major; 15-211 and 15-212 count toward total units for the General Education Program, DCR6, Science and Technology.

Logic and Computation Electives	36 units
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Bearing in mind prerequisites, Logic and Computation majors must complete four advanced courses in areas that use logical and computational tools, such as philosophy, computer science, linguistics, mathematical logic, psychology, or statistics. The sequence of courses, mostly at the 300-level, must be selected in consultation with the program director.

Sample Curricula

Here are five samples of Logic and Computation curricula (beyond the core courses), each reflecting a different emphasis.

Sample 1. A student interested in Computer Science might take the following courses:

80-315	Modal Logic
80-413	Category Theory
80-316	Causation, Probability and Artificial Intelligence
15-312	Programming Languages: Design and Processing

Sample 2. A student interested in Language and Information Technology might take the following courses:

80-280	Linguistic Analysis
80-306	Meaning in Language
80-480	Linguistic Theory
80-682	Introduction to Language Technologies

Sample 3. A student interested in Artificial Intelligence and Cognitive Science might take the following courses:

80-314	Logic in Artificial Intelligence
80-315	Modal Logic
80-316	Causation, Probability and Artificial Intelligence
85-412	Production System Models of Thought

Sample 4. A student interested in Logic and the Foundations of Mathematics might consider the following courses:

80-312	Philosophy of Mathematics
80-254	Analytic Philosophy
80-411	Proof Theory
80-413	Category Theory

Sample 5. A student interested in Methodology might consider the following courses:

80-220	Philosophy of Science
80-221	Philosophy of Social Science
80-321	Causation, Law, and Social Policy
36-309	Experimental Design

Logic and Computation Degree Requirements (min.) 360 units

Logic and Computation as a Second Major

The Logic and Computation major is also suitable as a second major for students in H&SS or for students in other colleges within the university. Non-H&SS students interested in an additional major in Logic and Computation need to take only those courses in the H&SS General Education Program that are prerequisites to courses required in the major; all other H&SS General Education requirements are waived for these students. Depending on the student's background, the requirements of the second major in Logic and Computation can be fulfilled with as few as five additional courses. However, the department limits the courses that may be 'double counted'; the core courses in the Philosophy department may not be double counted.

The M.S. Program in Logic and Computation

The Department of Philosophy also offers a graduate M.S. degree in Logic and Computation, which culminates with the writing of a master's thesis. It is ordinarily a two-year program, but students in the Logic and Computation major are able to complete the additional requirements in one year. Interested students are invited to contact the department for further information and apply to the program in their senior year. Details can be found on the department's homepage: <http://hss.cmu.edu/philosophy/>

The Major in Philosophy

Mara Harrell, Director

The Major in Philosophy is intended to be flexible and to facilitate double majors in other fields (including majors with a strong professional focus). It provides students with a broad humanities education and sharpens their analytical skills. We encourage, but do not require, students to choose a thematic concentration through their electives. Sample curricula emphasizing Pre-Law, Metaphysics and Epistemology, Ethics and Social Philosophy, and Philosophy of Mind are suggested below. However, alternative emphases can be proposed and approved by the Director. The Major in Philosophy is a B.A. degree.

Curriculum

In addition to the general education requirements of the student's college, Philosophy majors and double majors must complete nine Philosophy courses in the Areas listed below. Only two of these nine courses may be at the 100-level, and (for H&SS students) only one of them may be counted also as satisfying the College's General Education requirements (DCR 1 through 4). Students are to choose one course out of each of the Areas 1-4, two courses out of Area 5, and may freely select three courses in Area 6. These nine courses can be taken during the junior and senior year.

Area 1: Values and Normative Theory 9 units

One of the following:

80-x30 through 80-x34 Ethics/Ethical Theory
80-x35 through 80-x39 Social/Political Philosophy
80-x40 through 80-x49 Applied/Professional Ethics

Area 2: Philosophy of Mind/Language/Metaphysics 9 units

One of the following:

80-x70 through 80-x79 Philosophy of Mind/Metaphysics
80-x80 through 80-x89 Philosophy of Language

Area 3: Logic/Philosophy of Mathematics 9 units

One course from (80-x10 through 80-x19)

Area 4: Epistemology/Methodology 9 units

One of the following:

80-x00 through 80-x09 Epistemology/Methodology
(not counting 80-100 through 80-109)
80-x20 through 80-x29 Philosophy of Science

Area 5: History of Philosophy 18 units

Two of the following:

80-250 through 80-259 History of Philosophy
80-150 Nature of Reason
80-226 Revolutions in Science

Area 6: Electives 27 units

Three other philosophy courses, or appropriate courses from other departments, with the permission of the Director.

Sample Curricula

Here are four sample curricula, reflecting different emphases.

1. A sample Pre-Law program is:

Area 1	80-236	Philosophy and Law
Area 2	80-180	Nature of Language
Area 3	80-211	Logic and Mathematical Inquiry
Area 4	80-208	Critical Thinking
Area 5	80-150	Nature of Reasoning
	80-250	Ancient Philosophy
Area 6	80-242	Conflict and Dispute Resolution
	80-321	Causation, Law, and Social Policy
	80-348	Health, Development and Human Rights
	80-447	Global Justice

2. For an emphasis on Philosophy of Science a student might take:

Area 1	80-230	Ethical Theory
Area 2	80-271	Philosophy and Psychology
Area 3	80-211	Logic and Mathematical Inquiry
Area 4	80-220	Philosophy of Science
	or	
	80-221	Philosophy of Social Science

Area 5	80-250	Ancient Philosophy
	82-226	Revolutions in Science
Area 6	80-222	Measurement and Methodology
	80-322	Philosophy of Physics
	80-323	Philosophy of Biology

3. For an emphasis on Ethics and Social Philosophy a student might take:

Area 1	80-230	Ethical Theory
Area 2	80-276	Philosophy of Religion
Area 3	80-110	Nature of Mathematical Reasoning
Area 4	80-221	Philosophy of Social Science
	or	
	80-321	Causation, Law, and Social Policy
Area 5	80-250	Ancient Philosophy
Area 6	80-321	Causation, Law, and Social Policy

4. For an emphasis on Philosophy of Mind a student might take:

Area 1	80-130	Introduction to Ethics
Area 2	80-270	Philosophy of Mind
Area 3	80-211	Logic and Mathematical Inquiry
Area 4	80-201	Epistemology
Area 5	80-251	Modern Philosophy
	80-254	Analytic Philosophy
Area 6	80-271	Philosophy and Psychology
	80-300	Minds, Machines, and Knowledge
	80-316	Causation, Probability & Artificial Intelligence

Additional Major

Students who want an additional major in Philosophy must fulfill the same departmental requirements as primary majors in Philosophy.

The M.A. Program in Philosophy

The Department of Philosophy also offers a graduate M.A. degree in Philosophy, which culminates with the writing of a master's thesis. It is ordinarily a two-year program, but students in the Philosophy major are able to complete the additional requirements in one year. Interested students are invited to visit the department's homepage for further information: www.hss.cmu.edu/philosophy/.

Philosophy Department Minors

All majors in the Department allow for minors; in addition, there is a Minor in Ethics and an interdepartmental minor in Linguistics. The requirements are again designed to be flexible and to allow students to tailor courses to their special interests, while providing some breadth.

The Minor in Ethics

With the explosive growth of science and technology have come both new possibilities and new problems. Developments in medicine, in biology, in chemistry, in nuclear engineering or in computer science all have costs as well as benefits, and they present us with many hard choices. Some of the hardest of these new problems are moral problems.

The Philosophy Department's Minor in Ethics introduces students to central ethical concepts and theories proposed and defended by the great philosophers of the past; it provides an understanding of how these theories and concepts can be applied to practical problems. This background in ethical theory and its applications should help students to respond more sensitively and appropriately to the new and unavoidable ethical problems that businesses, unions, and branches of government must face.

Ethics Core Courses 27 units

Complete three courses from any of the following areas with at least two courses at the 200-level or higher.

80-x30 through 80-x34 Ethics / Ethical Theory
80-x35 through 80-x39 Social / Political Philosophy
80-x40 through 80-x49 Applied / Professional Ethics

Ethics Electives 18 units

Complete two courses at the 200-level or higher.

The Minor in Linguistics

The Interdepartmental Minor in Linguistics is jointly sponsored with the departments of English, Modern Languages, and Psychology. It synthesizes the linguistics related offerings in these departments and provides students with an academic experience that reflects both the interdisciplinary character of the subject and its cross-departmental representation in H&SS. Students who wish to receive a minor in Linguistics must complete six courses. For a detailed discussion of the curriculum and the flexible electives, consult the H&SS Interdisciplinary Minors section of the catalog.

The Minor in Logic and Computation

The Minor in Logic and Computation provides students with general course work in logic, the theory of computation, and philosophy. Students must complete six courses, among them the following three core courses.

Logic and Computation Core Courses 27 units

80-211	Logic and Mathematical Inquiry
or	
80-210	Logic and Proofs
80-300	Minds, Machines, and Knowledge
80-310	Logic and Computation
or	
80-311	Computability and Incompleteness

Logic and Computation Electives 27 units

Students must take two courses in the Philosophy Department at the 300-level or higher, in subjects related to logic and computation, and an additional course at the 300-level or higher in an area that uses logical and computational tools, such as philosophy, computer science, linguistics, mathematics, psychology, or statistics. The choice of electives must be approved by the program director.

The Minor in Philosophy

The Minor in Philosophy allows students to complement their primary majors with a broad philosophical grounding.

Logic/Methodology Requirements 9 units

Complete one course:
80-x10 through 80-x19 Philosophy of Logic/Mathematics
or
80-x20 through 80-x29 Philosophy of Science

History of Philosophy Requirements 18 units

Complete two courses:
80-250 through 80-259 History of Philosophy
80-150 Nature of Reason
80-226 Revolutions in Science

Philosophy Electives 18 units

Complete two courses in the Philosophy Department at the 200-level or higher.

The Honors Program

The H&SS Senior Honors Program provides recognition of outstanding performance by students majoring in Philosophy, Logic and Computation or Ethics, History, and Public Policy. Students have the opportunity to develop their skills and to apply their knowledge through completion of an honors thesis in their senior year. By completing the thesis, students earn 18 units of credit and qualify for graduation with College Honors. To qualify for the honors program, students must maintain a quality point average of at least 3.50 in the major and 3.25 overall, and be invited by the department to become a participant.

Undergraduate Research Fellows

Qualified upper level undergraduates, preferably majors in one of the Philosophy Department's programs, may apply to serve in their junior or senior years as fellows in the Laboratory for Symbolic and Educational Computing. Applications are reviewed in the fall. Follow the link to LSEC from the Department's home page: www.hss.cmu.edu/philosophy.

Faculty

HORACIO ARLO-COSTA, Associate Professor of Philosophy — Ph.D., Columbia University; Carnegie Mellon, 1998—.

JEREMY AVIGAD, Professor of Philosophy — Ph.D., University of California, Berkeley; Carnegie Mellon, 1996—.

STEVEN AWODEY, Professor of Philosophy — Ph.D., University of Chicago; Carnegie Mellon, 1997—.

ROBERT CAVALIER, Teaching Professor of Philosophy— Ph.D., Duquesne University; Carnegie Mellon, 1987—.

DAVID DANKS, Assistant Professor of Philosophy — Ph.D., University of California, San Diego, Carnegie Mellon, 2003—.

CLARK GLYMOUR, Alumni University Professor of Philosophy— Ph.D., Indiana University; Carnegie Mellon, 1984—.

MARALEE HARRELL, Associate Teaching Professor in Philosophy — Ph.D., University of California, San Diego, Carnegie Mellon, 2003—.

NICOLE HASSOUN, Assistant Professor of Philosophy — Ph.D., University of Arizona; Carnegie Mellon, 2007—.

KEVIN T. KELLY, Professor of Philosophy — Ph.D., University of Pittsburgh; Carnegie Mellon, 1985—.

ALEX LONDON, Associate Professor of Philosophy — Ph.D., University of Virginia; Carnegie Mellon, 2000—.

JOSEPH RAMSEY, Director of Research Computing — Ph.D., University of California, San Diego; Carnegie Mellon, 2006—.

RICHARD SCHEINES, Professor of Philosophy — Ph.D., University of Pittsburgh; Carnegie Mellon, 1987—.

DANA S. SCOTT, Hillman University Professor of Mathematical Logic, Computer Science and Philosophy (Emeritus) — Ph.D., Princeton University; Carnegie Mellon, 1981—.

TEDDY I. SEIDENFELD, Herbert A. Simon Professor of Philosophy and Statistics — Ph.D., Columbia University; Carnegie Mellon, 1985—.

WILFRIED SIEG, Patrick Suppes Professor of Philosophy — Ph.D., Stanford University; Carnegie Mellon, 1985—.

MANDY SIMONS, Associate Professor of Philosophy — Ph.D., Cornell University; Carnegie Mellon, 1998 —.

PETER L. SPIRITES, Professor of Philosophy — Ph.D., University of Pittsburgh; Carnegie Mellon, 1987—.

Department of Psychology

Michael Scheier, Department Head
 Department Office: Baker Hall 346-C
www.psy.cmu.edu

Can newborn infants perceive the world as we do, or is it just "a blooming buzzing confusion"? Do personality, beliefs and social factors influence health? How do scientists make discoveries, and what abilities make these insights possible? How does brain activity reveal differences in thinking? Can computers think the way people do?

These are some of the questions that psychologists at Carnegie Mellon are trying to answer.

For the student who is majoring in Psychology or Cognitive Science, studying with faculty who are on the leading edge of research on questions like the above can be a very exciting experience.

The Psychology Department at Carnegie Mellon has long been noted as one of the pioneering Psychology Departments in the world, particularly in such areas as cognitive psychology, cognitive science, social psychology, developmental psychology, cognitive neuroscience, and health psychology. The Psychology Department offers B.A. and B.S. degrees in Psychology, as well as a B.S. degree in Cognitive Science, and together with the Department of Biological Sciences, a unified B.S. major in Psychology and Biological Sciences.

The Major in Psychology

Psychology is a science which embraces both biological and social sciences. It is a science concerned with establishing principles and laws regarding the ways in which people think and behave through the scientific study of human behavior.

The orientation of the Carnegie Mellon Psychology curriculum is toward developing highly skilled and knowledgeable graduates. A bit more than half of our graduates go on to graduate or professional school. The remainder seek to expand their problem-oriented skills so that job opportunities beyond those typically open to liberal arts students are available.

Majors in the department are expected not only to learn about findings already established by psychologists, but also to become proficient in the investigation and analysis of behavior. This includes observing behavior, formulating hypotheses, designing experiments to test these hypotheses, running experiments, performing statistical analyses, and writing reports. The department has many resources for students to use in acquiring these skills. For instance, students interested in child development may be involved in the child development laboratory and observational facilities which are a part of the Carnegie Mellon Children's School. Students interested in environmental or health psychology might have opportunities to work in applied settings, and all Psychology majors have access to extensive computer facilities for data analysis and simulation work. The department also has a new state of the art set of undergraduate research laboratories and computer clusters.

In addition to formal class work, students are encouraged to participate in research, project and field work via a number of opportunities available to them. They may register for Independent Reading in Psychology, Independent Research in Psychology, or an Internship in Clinical or Developmental Psychology. In the Independent Research course, the student may work on an ongoing research project or develop and carry out a new research project with a faculty member. There is university and departmental funding available to help support student-initiated research projects and student travel to present research results at scientific meetings and conferences. In the Readings courses, the student reads extensively on a particular topic. The faculty member and student meet to discuss the readings, and the student writes a paper on the topic selected. The Psychology Department Website (www.psy.cmu.edu/), Graduate Catalog and Undergraduate Research Brochure provide descriptions of faculty research interests that the student can use in determining who should be approached to supervise a particular research or reading project. Clinical internships are available with a variety of clinical settings including the prestigious Western Psychiatric Institute and Clinic (the teaching hospital of the Department of Psychiatry at the University of Pittsburgh). During the internship, students get first-hand experience with different clinical populations. There is also a year long NIMH sponsored internship in mental health research in conjunction with the

University of Pittsburgh Department of Psychiatry. Developmental Internships are available in the department-run CMU Children's School. Finally, outstanding students are invited to participate in an Honors Program during their senior year. Over the course of their senior year, these students develop and carry out an original research project under faculty supervision.

Curriculum

The curriculum includes three levels of psychological course work. These result in a breadth of knowledge of psychology, training in research methods and in-depth advanced course work in student chosen areas of psychology. Both the B.A. and the B.S. degrees are available in Psychology. Candidates for both degrees must complete two semesters of calculus. There are three options in completing this requirement: 21-111/112 or 21-120 and either 21-122 or 21-256. Students are also required to complete a statistics sequence consisting of 36-201 or it's equivalent, followed by 36-309, Experimental Design. Both courses should be completed before the junior year. A one-semester computer programming course is also required for all Psychology majors. Finally, in addition to the H&SS General Education Natural Science requirement, B.A. candidates take one, and B.S. candidates take three additional semesters of natural science courses outside the department.

The Department desires that majors acquire breadth in the subject matter of Psychology and that they make informed choices among a set of required area survey courses. The requirement for demonstration of breadth can be met by taking Introductory Psychology (85-102) and three survey courses; it is recommended that this be started as early as possible in the student's program. Alternatively, the breadth requirement can be met by taking an additional Survey course beyond the required set of three survey courses.

There are three suggested major tracks starting with the 200-level survey courses. These are cognitive or cognitive-neuroscience, developmental, and social-personality. The tracks are designed to provide increasing depth of knowledge in a particular area of psychology, although the student may as an alternative elect to combine advanced courses from more than one area into a meaningful program.

Overall, the major includes Introduction to Psychology (or a 4th survey course), 36-309, three survey courses at the 200-level, two research methods courses, two advanced courses and an experimental design course. These include a total of 81 units. Advanced courses, which are often in the form of seminars, examine in great depth portions of the three track areas. The 18-unit advanced course requirement must be fulfilled by taking content seminars or courses rather than through Independent Research, Independent Reading, or Internship courses. In addition to the small number of required psychology courses, the department offers a variety of other courses, seminars, independent research and supervised experiences. Students are encouraged to sample these by means of the large number of elective units that are part of the program.

Prospective Psychology majors are encouraged to begin major requirements and prerequisites prior to the junior year, if possible. In particular, completion of the calculus and statistics sequences, Introduction to Psychology and/or one or more Psychology Survey courses would enable students to take corresponding research methods courses in the sophomore or early in the junior year, and thus prepare themselves to take advantage of research opportunities in the department.

Mathematics & Statistics Prerequisites	37-38 units
21-111 Calculus I and 21-112 Calculus II or 21-120 Differential Calculus/Integral Calculus (10 units) and 21-256 Multivariate Analysis and Approximation	

or
21-120 Differential and Integral Calculus (10 units)
and
21-122 Integration and Differential Equations and Approximation
(10 units)
36-201 Statistical Reasoning, Statistical Practice, or equivalent
36-309 Experimental Design for Behavioral and Social Sciences
(Prerequisite: 36-201 or equivalent)

Breadth Requirement 9 units

85-102 Introduction to Psychology or a fourth Survey Course*

* This, together with three survey courses, constitutes the breadth requirement.

Survey Courses 27 units

Complete three of the following survey courses.

85-211 Cognitive Psychology
or
85-213 Human Information Processing and Artificial Intelligence
85-219 Biological Foundations of Behavior
85-221 Principles of Child Development
85-241 Social Psychology
85-251 Personality

Research Methods 18 units

Complete two courses.

85-310 Research Methods in Cognitive Psychology*
85-320 Research Methods in Child Development*
85-340 Research Methods in Social Psychology*

*Prerequisites for all Research Methods courses: 36-309 or equivalent, and corresponding survey course.

(Note: 36-309 may be taken concurrently as a co-requisite)

Advanced Courses 18 units

Complete two courses.

85-341 or Any advanced content course or seminar in psychology
higher or any psychology course higher than 85-341.
Exceptions: 85-480, 85-482, 85-484, 85-505, 85-506,
85-507, 85-508

Computer Science Requirement 10 units minimum

15-100 or Introductory/ Intermediate Programming
higher

Natural Science Requirement (B.A. 9 units, B.S. 27 units)

The Psychology major requires (for B.S. candidates) three additional natural science courses (with two in the same science) beyond the College's General Education natural science requirement. For the B.A. the requirement is one course beyond the General Education requirement in natural science. Given the growing relevance of biology to psychology, it is strongly recommended that for the B.S. a minimum of two courses in biology be included as part of the natural science requirement.

More generally, for the B.S., at least two courses should come from the same science (biology, chemistry, or physics).

Sample Curriculum

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Survey Course	Survey Course	Advanced Course	Advanced Course
Experimental Design for Behavioral and Social Sciences 36-309	Research Methods Course	Research Methods Course	Elective
Supplementary Science Requirement B.A./B.S.	Supplementary Science Elective for B.S. only	Supplementary Science Elective for B. S. only	Elective
Computer Science Elective	Elective	Elective	Elective

This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years; not that it must be. Students may enter their major, and begin major course requirements, as early as the start of sophomore year, and in some instances in the first year. Students should consult their advisors when planning their programs.

Additional Major

In order to complete an additional major in Psychology, a student must fulfill all of the Psychology major requirements within the department — in other words, the breadth requirement, computing requirement, three survey courses at the 200-level, two research methods courses, and two advanced courses. These courses must include at least 81 units, plus calculus prerequisites and the 36-201 statistics course or equivalent and 36-309. In addition, B.S. candidates must take the three-course science requirement.

Unified Double Major in Psychology & Biological Sciences

This unified major is intended to reflect the interdisciplinary nature of our current research in the fields of Psychology and Biology, as well as the national trend in some professions to seek individuals broadly trained in both the social and natural sciences. Students entering from the College of Humanities and Social Sciences will earn a Bachelor of Science in Psychology and Biological Sciences. Students entering from the Mellon College of Sciences receive a Bachelor of Science in Biological Sciences and Psychology. Students entering from the Joint Science and Humanities Scholars (SHS) program can complete the SHS educational core and choose either departmental order for their diploma.

Specific Pre-Major Requirements

The unified major specifies particular pre-major requirements in the areas of Mathematical Sciences and Statistics, Natural Science, and Computational Reasoning. Particular courses are specified in these areas because they are prerequisites for courses required in the major and therefore they are the most efficient way to complete the general education requirements for either HSS or SHS. All other general education categories can be filled in any way that satisfies the requirements of the student's college of the SHS programs.

Mathematical Sciences/Statistics

21-120 Differential Calculus and Integral Calculus
21-122 Integration & Differential Equations and Calculus of Approximations
36-247 Statistics for Laboratory Sciences*
36-309 Experimental Design for Behavioral and Social Sciences

* 36-201 can be used as an alternative, but 36-247 is strongly encouraged.

Natural Sciences

09-105 Introduction to Modern Chemistry
09-106 Modern Chemistry II
33-xxx Physics I for Science Students
09-217 Organic Chemistry I
09-218 Organic Chemistry II

Computational Reasoning
 99-10x Computing @ Carnegie Mellon
 15-100 Introductory/Intermediate Programming

Discipline Core Requirements

Biological Sciences

03-121 Modern Biology
 03-231 Biochemistry
 03-240 Cell Biology
 03-330 Genetics

Psychology

85-102 Introduction to Psychology*

Complete three of the following courses (85-219 should be included as one of the three):

85-211 Cognitive Psychology
 85-213 Human Information Processing and Artificial Intelligence
 85-219 Biological Foundations of Behavior
 85-221 Principles of Child Development
 85-241 Social Psychology
 85-251 Personality

*NOTE: Students can also take four Survey courses, one of which should be 85-219 Biological Foundations of Behavior.

Laboratory/Research Methods Requirements

09-221 Chemistry Laboratory I
 09-222 Chemistry Laboratory II
 03-343 Experimental Genetics and Molecular Biology

Research Methods in Psychology

Complete one of the following:

85-310 Research Methods in Cognitive Psychology
 85-320 Research Methods in Developmental Psychology
 85-340 Research Methods in Social Psychology

Prerequisite for all Research Methods courses: 36-309, and corresponding psychology survey course.

(Note: 36-309 may be taken concurrently as a co-requisite)

Additional Laboratory Requirement:

Complete one additional laboratory experience either as an additional 85-xxx Research Methods course in Psychology or a second laboratory in Biological Sciences at the 300 level or above.

Advanced Psychology/Biological Sciences Electives: 54 units

1. Psychology Advanced Elective 1
2. Psychology Advanced Elective 2
3. Biology General Elective
4. Biology Advanced Elective 1 (03-360 recommended)
5. Biology Advanced Elective 2
6. Advanced Biological Sciences or Psychology Elective, 85-3xx or higher (Research recommended)

See Advanced Courses for details.

Additional comments:

If a student drops the unified major program, a second Research Methods course would be required to complete the B.S. in Psychology. If a student drops the unified major program, the following additional courses would be required to complete the B.S. in Biological Sciences: 09-214 Physical Chemistry, 33-xxx Physics II and a second, 300-level Biology laboratory course.

This program does not satisfy all of the requirements for pre-medical preparation. Advising is suggested to determine the additional courses needed for that program.

The Major in Cognitive Science

The Psychology Department offers a B.S. degree in Cognitive Science. The field of cognitive science has grown out of increasingly active interaction among psychology, linguistics, artificial intelligence, philosophy, and neuroscience. All of these fields share the goal of understanding intelligence. By combining these diverse perspectives, students of cognitive science are able to understand cognition at a deep level. Because this major is administered by the Psychology Department, it focuses on human cognition and the experimental study of the human mind as illuminated by the techniques of the above disciplines.

Curriculum

The Cognitive Science major is only offered as a B.S. degree. Candidates should complete before the junior year the two-semester calculus sequence 21-120/256 (or alternatively 21-120/122)* and a statistics sequence (36-201 or equivalent and if possible, 36-309). In addition, candidates complete 15-111 Intermediate/Advanced Programming, as their departmental computing course.

Because of the number and sequential nature of required courses, prospective Cognitive Science majors are encouraged to begin course work for the major prior to the junior year. In particular, completion of calculus, 36-201, and 85-211 or 85-213 before the junior year will enable students to complete 85-310 by the Fall semester of the junior year and, if interested, to then take advantage of research opportunities in the department.

Similarly, completion of 15-111 and 21-127 early in their program of studies will allow students to move into the 15-211/15-251 sequence by the Junior year and prepare them for further work in artificial intelligence.

*The 3-Semester sequence 21-111/112/256 may be substituted by students who have already taken 21-111 before deciding on the major.

Computing Prerequisite 10 units

15-111 Intermediate/Advanced Programming*

*prerequisite for 15-211

Mathematics & Statistics Prerequisites 37-38 units

21-120 Differential and Integral Calculus (10 units)*

and

21-256 Multivariate Analysis and Approximation

or

21-120 Differential and Integral Calculus (10 units)

and

21-122 Integration, Differential Equations and

Approximation (10 units)

21-127 Concepts of Mathematics+

36-201 Statistical Reasoning, Statistical Practice or

equivalent

36-309 Experimental Design for the Behavioral and Social

Sciences

+Along with 15-111, prerequisite for 15-211.

Artificial Intelligence Core (minimum) 33 units

15-211 Fundamental Data Structures and Algorithms I

15-251 Great Theoretical Ideas in Computer Science

15-381 Artificial Intelligence: Representation and Problem

Solving or

85-412 Cognitive Modeling

or

85-419 Introduction to Parallel Distributed Processing

Cognitive Psychology Core 27 units

85-211 Cognitive Psychology

or

85-213 Human Information Processing and Artificial

Intelligence

85-310 Research Methods in Cognitive Psychology

(Prerequisite for all research methods courses 36-309 and corresponding psychology survey course)

Plus complete one of the following:

85-412 Cognitive Modeling

85-414 Cognitive Neuropsychology

85-419 Introduction to Parallel Distributed Processing

85-423 Cognitive Development

Cognitive Science Concentration Requirement 36 units

Note: The courses to fulfill this requirement should be chosen in collaboration with the student's academic advisor.

Complete four courses from the following course listing. These four courses should be combined into an area of concentration that may include courses from more than one department developed in cooperation with the student's major advisor. As the curriculum evolves, other courses may also be appropriate, and may be selected in consultation with one's psychology faculty advisor.

One example of a concentration area would be cognitive modeling which might involve taking four of the following: 85-412, 85-419, 85-392, 85-417 (05-432 cross-listed course number in HCI) and 05-811 Cognitive Modeling for HCI. Another area might be cognitive neuroscience and could involve four of the following: 85-370 Perception, 03-360 The Biology of the Brain, 85-414 Cognitive Neuropsychology, 85-419 Introduction to Parallel Distributed Processing, 85-429 Cognitive Brain Imaging, and 85-465 Cognitive Neuroscience.

Other areas that might be chosen include: human-computer interaction, machine learning, psycholinguistics, perception and natural language processing. Many other possibilities also exist.

Computer Science

15-384	Robotic Manipulation
15-385	Artificial Intelligence: Computer Vision
15-453	Formal Languages and Automata
10-601	Machine Learning
05-410	Introduction to Human Computer Interaction Methods

Psychology

85-219	Biological Foundations of Behavior
85-352	Evolutionary Psychology
85-355	Introduction to Cognitive Neuroscience
85-370	Perception
85-375	Cross Cultural Psychology
85-380	In Search of Mind: The History of Psychology
85-382	Consciousness & Cognition
85-390	Human Learning and Memory
85-392	Human Expertise
85-395	Applications of Cognitive Science
85-406	Seminar on Autism
85-412	Cognitive Modeling
85-413	Human Factors
85-414	Cognitive Neuropsychology
85-417	Cognitive Modeling and Intelligent Tutoring Assessment
85-419	Introduction to Parallel Distributed Processing
85-421	Language and Thought
85-422	Infancy
85-423	Cognitive Development
85-429	Cognitive Brain Imaging
85-601/602	Senior Thesis
66-501/502	Honors Thesis

Philosophy

80-210	Logic and Proofs
80-211	Logic and Mathematical Inquiry
80-220	Philosophy of Science
80-254	Analytic Philosophy
80-255	Pragmatism
80-270	Philosophy of Mind
80-271	Philosophy and Psychology
80-300	Minds, Machines and Knowledge
80-310	Logic and Computation
80-311	Computability and Incompleteness
80-314	Causation, Logic and Artificial Intelligence
80-316	Probability and Artificial Intelligence
80-535	Seminar in Epistemology

Linguistics

76-385	Introduction to Discourse Analysis
80-280	Linguistic Analysis
80-306	Meaning in Language

Decision Sciences

88-302	Behavioral Decision Making
88-356	Rational Choice

Neurosciences

03-360	The Biology of the Brain
42-202	Physiology

Appropriate courses offered by the Department of Neurosciences at the University of Pittsburgh (available during the academic year through cross-registration) may also be included as part of this breadth option. This would include the following courses (course numbers are University of Pittsburgh numbers, offered through its Department of Neurosciences):

NROSCI1000	Introduction to Neuroscience
NROSCI1011	Functional Neuroanatomy
NROSCI1012	Neurophysiology
NROSCI1017	Synaptic Transmission
NROSCI1030	Psychiatric Disorders and Brain Function
NROSCI1032	Functional Organization of the Human Nervous System
NROSCI1034	Neural Basis of Cognition
NROSCI1036	Neurobiology of Aging
NROSCI1040	Biological Basis of Learning and Memory
NROSCI1041	Developmental Neuroscience
NROSCI1042	Neurochemical Basis of Behavior

Supplementary Science Requirement (minimum) 18 units

The Cognitive Science program requires two additional science courses (in the same science) beyond the college's two-course Science and Technology General Education requirement.

These can be selected from any one of the following areas.

03-xxx Biology*

09-xxx Chemistry 33-xxx Physics

*Those interested in a cognitive neuroscience focus are recommended to take biology courses, including if possible, 03-360, The Biology of the Brain.

Sample Curriculum

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Fundamental Structures of Computer Science 15-211	Great Theoretical Ideas in Computer Science 15-251	Third Artificial Intelligence Course	Elective
Cognitive Psychology Core Course 85-211 or 85-213	Research Methods in Cognitive Psychology 85-310	Cognitive Psychology Core Course 85-412, 85-419 or 85-423	Elective
Environmental Design for Behavioral and Social Sciences 36-309	Elective	Cognitive Science Breadth Requirement	Cognitive Science Breadth Requirement
Elective	Elective	Elective	Elective

This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in a few as two years; not that it must be. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the first year. Students should consult their advisors when planning their programs.

Additional Major

In order to complete a double major in Cognitive Science, a student must fulfill the major requirements as listed under the Cognitive Science major. These include the programming requirement (15-111), the Mathematics and Statistics prerequisites, the A.I. Core, The Cognitive Psychology Core, the Cognitive Science Breadth Requirement, and the Supplementary Science Requirement. Students will be assigned a department advisor to help plan their program of studies in Cognitive Science.

The Minor in Psychology

This minor in Psychology is available to all students across the university.

There are three broad areas of concentration in the department, as defined by the three research methods courses together with associated prerequisite survey courses and related advanced courses and seminars.

Curriculum 73 units

I. Introductory courses 9 units

Complete only one of these courses.

85-100 Introduction to Intelligence in Humans, Animals, and Machines
85-102 Introduction to Psychology

II. Area Survey courses 18 units

Complete two courses.

85-211 Cognitive Psychology
or
85-213 Human Information Processing and Artificial Intelligence
85-219 Biological Foundations of Behavior
85-221 Principles of Child Development
85-241 Social Psychology
85-251 Personality

III. Statistics 19 units

36-201 Statistical Reasoning, Statistical Practice or equivalent
36-309 Experimental Design for the Behavioral and Social Sciences

Upper Level Courses 27 units

Complete three courses from categories IV and V, with at least one course from each.

IV. Research Methods Courses (minimum 9 units)

85-310 Research Methods in Cognitive Psychology*
85-320 Research Methods in Child Development*
85-340 Research Methods in Social Psychology*

*Prerequisites for all Research Methods courses: 36-309 and the appropriate survey course.

(Note: 36-309 may be taken concurrently as a co-requisite.)

V. Advanced courses (minimum 9 units)

These courses exist within three areas (cognitive, cognitive neuroscience, developmental and social psychology), and carry course numbers from 85-341 to 85-599. In cases where it is not obvious which track an advanced course belongs to from the title/description, the advanced courses usually include the appropriate survey course or research method course as a prerequisite in their catalog course description

The Honors Program

The Honors Program provides recognition of outstanding performance by students in Psychology or Cognitive Science. Participation enables students to pursue their own research ideas through completion of an honors thesis. The honors thesis is completed during the senior year. By completing a thesis, the student earns 18 units of credit and qualifies for graduation with "College Honors." To qualify for the Honors Program, the student must maintain a quality point average of at least 3.50 in the major and 3.25 overall, and be invited by the college to become a participant. A year long senior thesis course exists for students interested in pursuing a sizable research project who do not qualify for the honors program.

Faculty

JOHN R. ANDERSON, Richard King Mellon University Professor of Psychology and Computer Science — Ph.D., Stanford University; Carnegie Mellon, 1978—.

MARLENE BEHRMANN, Professor of Psychology — Ph.D., University of Toronto; Carnegie Mellon, 1993—.

PATRICIA A. CARPENTER, Lee and Marge Gregg Professor of Psychology — Ph.D., Stanford University; Carnegie Mellon, 1972—.

SHARON CARVER, Director of Children's School, Teaching Professor of Psychology, — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1993—.

SHELDON COHEN, Professor of Psychology — Ph.D., New York University; Carnegie Mellon, 1982—.

CHANTE COX-BOYD, Associate Teaching Professor — Ph.D., University of North Carolina at Chapel Hill; Carnegie Mellon, 2001—.

DAVID CRESWELL, Assistant Professor — Ph.D., University of California, Los Angeles; Carnegie Mellon, 2008—.

BROOKE C. FEENEY, Associate Professor of Psychology — Ph.D., State University of New York at Buffalo; Carnegie Mellon, 2001—.

ANNA FISHER, Assistant Professor — Ph.D., The Ohio State University; Carnegie Mellon, 2006—.

JOHN R. HAYES, Professor of Psychology — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1965—.

VICKI S. HELGESON, Professor of Psychology — Ph.D., University of Denver; Carnegie Mellon, 1990—.

LORI L. HOLT, Associate Professor — Ph.D., University of Wisconsin; Carnegie Mellon, 1999 —.

MARCEL A. JUST, D. O. Hebb Professor of Psychology — Ph.D., Stanford University; Carnegie Mellon, 1972—.

CHARLES KEMP, Assistant Professor — Ph. D., Massachusetts Institute of Technology; Carnegie Mellon, 2008—.

DAVID KLAHR, Walter van Dyke Bingham Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1969—.

ROBERTA KLATZKY, Professor of Psychology, — Ph.D., Stanford University; Carnegie Mellon, 1993—.

KENNETH R. KOEDINGER, Professor of HCII — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2001—.

KENNETH KOTOVSKY, Professor of Psychology, Director, Undergraduate Studies in Psychology — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1988—.

MARSHA C. LOVETT, Associate Research Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2000 —.

BRIAN MACWHINNEY, Professor of Psychology — Ph.D., University of California, Berkeley; Carnegie Mellon, 1981—.

DAVID PLAUT, Professor of Psychology — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1994—.

DAVID RAKISON, Associate Professor — D.Phil., University of Sussex; Carnegie Mellon, 2000 —.

LYNNE M. REDER, Professor of Psychology — Ph.D., University of Michigan; Carnegie Mellon, 1978— .

MICHAEL F. SCHEIER, Professor of Psychology, Head, Psychology Department — Ph.D., University of Texas; Carnegie Mellon, 1975—.

ROBERT S. SIEGLER, Heinz Professor of Psychology — Ph.D., State University of New York, Stony Brook; Carnegie Mellon, 1974—.

JAMES J. STASZEWSKI, Research Professor — Ph.D., Cornell University; Carnegie Mellon, 1995 —.

ERIK D. THIESEN, Assistant Professor — Ph.D., University of Wisconsin, Madison; Carnegie Mellon, 2004 —.

Department of Social and Decision Sciences

Department Office: Porter Hall 208
www.hss.cmu.edu/sds.html

The Department of Social and Decision Sciences is a multidisciplinary department that offers undergraduate programs that seamlessly combine frontier knowledge in the social sciences with the practical skills needed to excel in key decision making roles in the public and private sectors and in advanced studies. Our students learn how to combine intellectual ideals with the realities of human and organizational behavior and to apply these lessons across a wide variety of endeavors, ranging from government service to leadership positions in the information economy.

The department offers undergraduate majors in Decision Science and Policy and Management, and oversees the Global Politics major offered by the Global and International Relations Program. The majors leverage off of our departmental core that includes courses in decision analysis, empirical research, organizations, and policy analysis. In addition to completing this core, students also specialize in their major area through a set of required and elective courses.

Our faculty is committed to the academic success and growth of our students. For example, many of our undergraduates work with faculty on research projects and internships. The directors of the majors are easily accessible and encourage students to talk with them about the curriculum, progress, and available opportunities.

The Department of Social and Decision Sciences has a long history of creating innovative and prescient undergraduate programs that combine key ideas from across the social sciences into cohesive majors that allow our graduates to excel in their chosen professions or in the pursuit of advanced studies. Our emphasis on the theory and practice of individual and social decision making linked with our high-quality, multidisciplinary social science faculty, provides a solid foundation from which graduates can embrace a variety of future paths.

The Major in Decision Science

Baruch Fischhoff, Faculty Director
Office: Porter Hall 219E
Connie Angermeier, Academic Advisor
Office: Porter Hall 208A

The interdisciplinary field of Decision Science seeks to understand and improve the judgment and decision making of individuals, groups, and organizations. Qualified graduates can continue to PhD programs in Decision Science or related fields (e.g., psychology, business), pursue professional degrees (e.g., MBA, MD, JD, MPH), or take professional positions in business, government, consulting, or the non-profit sector. Students work with faculty to tailor their education to their specific needs and interest.

Carnegie Mellon is one of the leading centers for the study of Decision Science – and was the first to offer the only such undergraduate major. Our faculty are involved in applying Decision Research in a wide variety of areas, allowing them to share practical experiences with students. These applications include medical decision making (e.g., conveying the costs and benefits of treatment options), legal decision making (e.g., understanding the effects of anger on attributions of responsibility), societal risk management (e.g., assessing and communicating the risks of terrorist attacks), marketing (e.g., understanding the effects of intertemporal choice on purchasing decisions), and business (e.g., identifying unrecognized conflicts of interest).

Decision Science is grounded in theories and methods drawn from psychology, economics, philosophy, statistics, and management science. Courses in the major cover the three aspects of decision science: (a) normative analysis, creating formal models of rational choice; (b) descriptive research, studying how cognitive, emotional, social, and institutional factors affect judgment and choice, and (c) prescriptive interventions, seeking to improve judgment and decision making. In addition to gaining a broad education in the principles of judgment and decision making, Decision Science majors gain broadly applicable skills in research design and analysis. They also have the chance to think about and discuss decision making in many different areas.

The core courses in Decision Science cluster into two categories. The theory cluster presents fundamental theories and results from the empirical study of decision making, as well as the application of decision-making research to real-world problems. The research methods cluster introduces students to methods for collecting and analyzing behavioral data. For example, students learn to conduct surveys (e.g., uncovering consumer or managerial preferences), design experiments evaluating theories, and evaluate the effectiveness of interventions.

The elective courses provide students with additional knowledge in areas of decision making that meet their personal intellectual and career goals. These courses are organized into four clusters: biological and behavioral aspects of decision making, managerial and organizational aspects, philosophical and ethical perspectives, and research methods. Students can concentrate in one area or spread their studies across them. In addition to coursework, the department offers research opportunities for interested and qualified students. Participating in research helps students to extend their mastery of decision science, discover whether a research career is right for them, and get to know faculty and graduate students better.

Prerequisites

All Decision Science majors must complete mathematics and statistics prerequisites (see below), by the end of the sophomore year.

Mathematics Prerequisite (10-20 units)

21-111 Calculus I AND 21-112 Calculus II (10 units each)
OR
21-120 Differential and Integral Calculus (10 units)

Statistics Prerequisite (9 units)

36-201 Statistical Reasoning and Practice (9 units)

Curriculum 108 units

The core curriculum in Decision Science consists of two courses in empirical research methods and five courses providing the disciplinary perspectives of Decision Science.

Disciplinary Perspectives 45 units

88-120	Reason, Passion, and Social Cognition**
85-211	Cognitive Psychology
88-220	Policy Analysis I
88-223	Decision Analysis and Decision Support Systems
88-302	Behavioral Decision Making

** 88-120 should be taken in the freshman or sophomore year.

Research Methods 18 units

36-202	Statistical Methods
88-251	Empirical Research Methods

Electives 45 units

Complete five courses from the following categories of courses. Most courses listed below are 9-unit courses, but some are less. When courses offered for less than 9 units are chosen, students should note that a minimum of 45 units is required, and should plan to take one or more additional courses as appropriate. The selected courses may be from one category or from any combination of categories.

At least two of these courses (18 units) must be Department of Social and Decision Sciences courses (88-xxx).

1. Biological and Behavioral Aspects of Decision Making

- 85-219 Biological Foundations of Behavior
- 85-241 Social Psychology
- 85-352 Evolution Psychology
- 85-355 Introduction to Cognitive Neuroscience
- 85-414 Cognitive Neuropsychology
- 85-442 Health Psychology
- 88-307 Irrationality
- 88-360 Behavioral Economics
- 88-377 Attitudes and Persuasion
- 88-386 Desires and Decisions
- 88-407 Health Risk Communication

Appropriate courses offered by the Department of Neuroscience at the University of Pittsburgh (available during the academic year through cross-registration) may also be included as part of this option. Contact the Decision Science faculty director for more information.

2. Managerial and Organizational Aspects of Decision Making

- 70-332 Business, Society and Ethics
- 70-381 Marketing
- 70-481 Marketing Research
- 88-221 Policy Analysis II
- 88-222 Policy Analysis III
- 88-341 Organizational Communication
- 88-444 Public Policy & Regulation

3. Philosophical and Ethical Perspectives on Decision Making

- 19-426 Environmental Decision Making
- 80-208 Critical Thinking
- 80-241 Ethical Judgments in Professional Life
- 80-242 Conflict, Dispute Resolution
- 80-271 Philosophy and Psychology
- 80-305 Rational Choice
- 80-321 Causation and Social Policy
- 80-340 Environmental Ethics and Decision Making
- 80-346 Value Fact and Policy

4. Economic and Statistical and Methods for Decision Science

- 73-325 Strategic Behavior in Non-cooperative Games
- 73-347 Game Theory for Economists
- 73-435 Economics of Negotiations
- 80-316 Causation Probability & AI
- 80-405 Game Theory*
- 88-316 Game Theory*
- 88-360 Behavioral Economics
- 88-387 Social Norms and Economics

*80-405 and 88-316 are different courses and are not cross-listed.

5. Research Methods for Decision Science

- 36-303 Sampling, Survey and Society
- 36-310 Fundamentals of Statistical Modeling
- 80-330 Research Ethics
- 85-340 Research Methods in Social Psychology

Note: Some courses have additional prerequisites.

Decision Science, B.S.

Sample Curriculum*

Freshman or Sophomore Year	Junior Year		Senior Year		
	Spring	Fall	Spring	Fall	Spring
Reason, Passion, & Cognition** 88-120	Policy Analysis I 88-220	Decision Analysis & Support Systems 88-223	Decision Science Elective	Decision Science Elective	
Statistical Methods 36-202	Behavioral Decision Making 88-302	Empirical Research Methods 88-251	Decision Science Elective	Decision Science Elective	
Open Prerequisite	Cognitive Psychology 85-211	Decision Science Elective	Elective or Honors Thesis	Elective or Honors Thesis	
Elective	Elective	Elective	Elective	Elective	
Elective	Elective	Elective	Elective	Elective	

*This is presented as a two-year (junior-senior) plan for completing major requirements, with the exception of 88-120 and 36-202. Its purpose is to show that this program can be completed in as few as two years; not that it must be. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the freshman year. Students should consult their advisor when planning their program. Students who are planning to study abroad or to apply for the Heinz Accelerated Masters Program will have a very different curriculum map and should consult early – and often – with the Academic Advisor.

** This course should be taken as the first course in the Decision Science sequence. It is intended for students in their first or second year; it is offered in Spring semesters. It may be taken as late as the junior year.

Additional Major in Decision Science

Students who elect Decision Science as an additional major must fulfill all of the requirements of the Decision Science major.

Students pursuing Global Politics with an additional major in Decision Science may only count 36-202, 88-220, and 88-251 toward the completion of both majors.

Students pursuing Policy and Management with an additional major in Decision Science and may only count 36-202, 88-220, 88-223, and 88-251 toward the completion of both majors.

Additional majors cannot count menu electives toward simultaneously fulfilling more than one major or minor. Students who are interested in an additional major in Decision Science should see the Academic Advisor of the Decision Science program.

The Major in Global Politics

Kiron K. Skinner, Faculty Director
Office: Porter Hall 223H
Traci E. Sebastian, Academic Advisor
Office: Baker Hall A60C

Global politics is about the intersection of politics, markets, culture, and technology; the declining significance of the distinction between domestic politics and international relations; the challenges from migration, economic and political transitions, disease, environmental changes, and war; and the often transcendent power of identity, ideology, nationalism, religion, culture, and technology on state and non-state actors. No single discipline can fully grapple with what it means to live in a global society, but analytical social science provides important insights.

Students majoring in Global Politics will become conversant in the theoretical underpinnings of the study of international relations. They will also be trained to apply analytical tools such as rational choice theory, political history, economic analysis, and theories of behavioral decision-making to enduring problems in the global system.

The seven Global Politics core courses are rooted in analytical social science. Courses in decision processes in American political institutions, empirical research methods, and quantitative analysis provide a context for the study of international politics and political economy.

Global Politics students will also select five elective courses from three categories: International Political Economy, International Politics, and International Cultures. Courses in the International Political Economy and International Politics categories examine the interaction of political and economic forces in the international system, as well as the impact of national security issues on interstate and intrastate relations. The courses in these categories also prepare students to think systematically about the role of transnational forces in the international system. The International Cultures category is intended to inform the understanding of global political systems by examining the cultural underpinnings of modern societies.

As language study and international experiences are key elements to comprehending the context of global issues, Global Politics students are strongly encouraged to study abroad and to pursue competency in a second language. It is expected that students will have studied at least one foreign language through the 200-level; this will be especially important for students planning to study abroad.

The Global Politics major prepares students for more informed and effective participation in global society, as well as for a wide array of careers. Global Politics provides a valuable background for those pursuing careers domestically or abroad in business, government, international development, the nonprofit sector, or in multinational organizations. The major also provides a solid preparation for graduate study in international relations, law, public policy, business, and political science.

Prerequisites

All Global Politics majors must complete mathematics and statistics prerequisites (see below) by the end of the sophomore year.

Mathematics and Statistics Prerequisites 19-29 units

21-111 Calculus I AND 21-112 Calculus II (10 units each)
OR

21-120 Differential and Integral Calculus (10 units)

36-201 Statistical Reasoning and Practice

Curriculum 108 units

Core Courses 63 units

36-202 Statistical Methods
88-104 Decision Processes in American Political Institutions
88-205 Comparative Politics
88-220 Policy Analysis I
88-221 Policy Analysis II
88-251 Empirical Research Methods
88-326/
79-350 Theories of International Relations

Electives 45 units

Students will select five courses from the following categories. Students must take at least one course from each category, with no more than two courses from any given category. At least two of

these courses (18 units) must be from the Department of Social and Decision Sciences (88-xxx). Most courses listed below are 9-unit courses, but some are fewer. When courses offered for fewer than 9 units are chosen, students should note that a minimum of 45 units is required, and should plan to take one or more additional courses as appropriate.

1. International Political Economy

70-365 International Trade and International Law
70-430 International Management
73-371 International Trade and Economic Development
73-372 International Money and Finance
79-301 African Entrepreneurs/Entrepreneurs in Africa: Past, Present, and Future
80-136 Social Structure, Public Policy and Ethical Dilemmas
80-244 Environmental Ethics
80-340 Management, Environment and Ethics
80-348 Health, Development, and Human Rights
80-447 Global Justice
88-378 International Economics
88-410 The Global Economy: A User's Guide
88-411 The Rise of the Asian Economies

2. International Politics

88-329/
79-231 American Foreign Policy
88-357 Comparative Foreign Policy
88-358 Policy Making Institutions
88-359 Globalization
88-370 African Politics
88-384 Conflict and Conflict Resolution in International Relations

3. International Cultures

300-level language course (at most one for this category)

70-342 Managing Across Cultures
76-318 Communicating in the Global Marketplace
76-322 Global Masala: South Asians in the Diaspora
76-449 Culture and Globalization
79-205 20th Century Europe
79-212 Disastrous Encounters: Technology and the Environment in Global Historical Context
79-233 The US and Middle East Since 1945
79-248 History and Theory of Property
79-258 Introduction to African History
79-260 Mayan America
79-263 From Soil to Oil: Energy, Ecology, and Globalization
79-264 China's Neighbors
79-271 Modern China
79-276 North of the Border: Mexican Immigration Past and Present
79-278 China's Environmental Crisis
79-281 Russian History: From Communism to Capitalism
79-288 Bananas, Baseball, and Borders: A History of Latin America-US Relations
79-290 Between Revolutions: The Development of Modern Latin America
79-294 The Marking of the African Diaspora in the New World
79-295 Germany and World War II
79-307 The Anthropology of Europe
79-314 Nationalities and the New States of the Former USSR
79-336 Epidemic Disease and Public Health
79-340 History of Modern Warfare
79-342 Introduction to Science and Technology Studies
79-352 The Arab-Israeli Condition: War and Peace
79-380 Experiencing Globalization
79-397 Religion and Politics in the Middle East
82-304 Francophone World
82-323 Germany, Austria and Switzerland in the 20th Century
82-324 Contemporary Germany, Austria and Switzerland
82-325 Introduction to German Studies
82-333 Introduction to Chinese Language and Culture
82-342 Spain: Language and Culture
82-343 Latin America: Language and Culture
82-345 Introduction to Hispanic Literary and Cultural Studies
82-404 Francophone Realities: Africa
82-424 New Germany
82-431 China and the West
82-432 Popular Culture in China
82-441 Studies in Peninsular Literature and Culture
82-451 Studies in Latin American Literature and Culture
82-455 Topics in Hispanic Studies
82-474 Topics in Japanese Studies

NOTE: Some courses have additional prerequisites.

Global Politics, B.S.

Sample curriculum*

Freshman or Sophomore Year	
Fall	Spring
Decision Processes in American Political Institutions** 88-104	Statistical Methods 36-202
Open Prerequisite	Open Prerequisite
Gen Ed or Elective	Gen Ed or Elective
Gen Ed or Elective	Gen Ed or Elective
Gen Ed or Elective	Gen Ed or Elective

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Theories of International Relations 88-326	Comparative Politics 88-205	Global Politics Elective	Global Politics Elective
Policy Analysis I 88-220	Policy Analysis II 88-221	Global Politics Elective	Global Politics Elective
Global Politics Elective	Empirical Research Methods 88-251	Elective or Honors Thesis	Elective or Honors Thesis
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

*This is presented as a two-year (junior–senior) plan for completing major requirements, with the exceptions of 88-104 and 36-202. Its purpose is to show that this program can be completed in as few as two years; not that it must be. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the freshman year. Students should consult their advisor when planning their program.

** This course should be taken as the first course in the Global Politics sequence. It is intended for students in their first or second year.

Global Politics, B.S.

Sample curriculum for students who wish to study abroad*

Freshman or Sophomore Year	
Fall	Spring
Decision Processes in American Political Institutions** 88-104	Statistical Methods 36-202
Open Prerequisite	Open Prerequisite
Gen Ed or Elective	Gen Ed or Elective
Gen Ed or Elective	Gen Ed or Elective
Gen Ed or Elective	Gen Ed or Elective
Gen Ed or Elective	Gen Ed or Elective

Junior Year		Senior Year	
Fall	Spring	Fall	Spring
Theories of International Relations 88-326	Study Abroad Semester (taking two GP electives)	Policy Analysis I 88-220	Policy Analysis II 88-221
Global Politics Elective	Global Politics Elective	Global Politics Elective	Comparative Politics 88-205
Elective	Global Politics Elective	Global Politics Elective	Empirical Research Methods 88-251
Elective	Elective	Elective or Honors Thesis	Elective or Honors Thesis
Elective	Elective	Elective	Elective

*All students are strongly encouraged to spend a semester on a study abroad program, and this plan demonstrates that students can still complete the program in a few as two years, with the exceptions of 88-104 and 36-202. Planning and consultation with their advisor and the Study Abroad Office are essential. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the freshman year.

** This course should be taken as the first course in the Global Politics sequence. It is intended for students in their first or second year.

Additional Major

Students who elect Global Politics as part of an additional major must fulfill all of the requirements of the Global Politics major.

Students pursuing Decision Science with an additional major in Global Politics may only count 36-202, 88-220, and 88-251 toward the completion of both majors.

Students pursuing Policy and Management with an additional major in Global Politics may only count 36-202, 88-220, 88-221, and 88-251 toward the completion of both majors.

Additional majors cannot count menu electives toward simultaneously fulfilling more than one major or minor.

The Major in Policy and Management

Paul Fischbeck, Director
Office: Porter Hall 208F
Connie Angermeier, Academic Advisor
Office: Porter Hall 208A

The Policy and Management major prepares students for key decision-making and management roles in government, the non-profit sector, and business. The major emphasizes analytic approaches to decision making, management, and organization, and combines such knowledge with the practical skills necessary for graduates to excel in both the public and private sectors. The multidisciplinary curriculum merges frontier knowledge on both the ideals of decision making, policy, and organization, as well as the realities of individual and organizational behavior that must be confronted if high-quality outcomes are going to be attained.

The major is comprised of four clusters of courses. The Analytic Methods requirement consists of four courses that provide theoretical training and practical experience in problem solving and decision making. These courses provide systematic methods for dealing with the complexities that make decisions difficult, ranging from incorporating issues of risk and uncertainty in decision making to dealing with choices that have mutually conflicting objectives. For example, a business or government agency may need to decide on a policy for mitigating the uncertain impacts of air pollution while simultaneously trying to minimize the costs of such a policy on manufacturing. A firm might want to consider the uncertain reductions in security dangers from alternative policies to protect against terrorism. In this requirement, students will gain an appreciation of the economic analysis of complex decisions, as well as the trade-off between economic and political-based decision making.

The Organizational Context requirement is a course that emphasizes the analysis of how people organize and coordinate their behavior to perform complex tasks that are beyond the capability of any single individual. The course uses a multidisciplinary approach to analyze the potential shortcomings of large organizations, such as inertia, group-think, coordination failure, and bureaucratic infighting.

The Research Methods requirement is comprised of two courses focused on key methods for collecting and analyzing data that are needed to make informed decisions. Students learn to use interviews, surveys, experiments, and econometric methods to enhance their ability to test existing, and design new, policies.

Finally, the Electives requirement consists of five courses chosen by the student, in coordination with the Academic Advisor, to add depth and breadth to the major. These courses are chosen from five categories that emphasize different aspects of decision making and management: (1) policy making, (2) management, (3) technology and information, (4) international policy, and (5) political science and law. The selected courses may be from one category or from any combination of categories.

The Policy and Management major provides an excellent combination of theoretical and practical skills for students who intend to seek managerial positions. Because of its strong analytic orientation, it is also an excellent major for those who intend to go on to professional school programs in law, business, or public policy. It is also an appropriate choice for students pursuing graduate degrees in economics, political science, or decision science. One such graduate option is the accelerated masters program offered by the H. J. Heinz III School of Public Policy and Management, in which a student earns both a B.S. in Policy and Management and a M.S. in Public Policy and Management in five years.

Prerequisites

All Policy and Management majors must complete mathematics and statistics prerequisites (see below), by the end of the sophomore year.

Mathematics Prerequisites	(19-30 units)
21-111 Calculus I <u>AND</u> 21-112 Calculus II	(10 units each)
OR	
21-120 Differential and Integral Calculus	(10 units)
21-122 Integration, Differential Equations and Approximation	(10 units)
OR	
21-256 Multivariate Analysis and Approximation	(9 units)

Statistics Prerequisite

36-201 Statistical Reasoning and Practice (9 units)

Curriculum 111 units

Analytical Methods 39 units

88-220 Policy Analysis I
88-221 Policy Analysis II
88-222 Policy Analysis III
88-223 Decision Analysis and Decision Support Systems

Organizational Context 9 units

88-260 Organizations

Research Methods 18 units

36-202 Statistical Methods
88-251 Empirical Research Methods

Electives 45 units

Complete five courses from the following categories of courses. Most courses listed below are 9-unit courses, but some are less. When courses offered for less than 9 units are chosen, students should note that a minimum of 45 units is required, and should plan to take one or more additional courses as appropriate. The selected courses may be from one category or from any combination of categories.

At least three of these courses (27 units) must be Social and Decision Sciences courses (88-xxx).

1. Policy Making

73-340 Labor Economics
73-352 Public Economics
73-357 Regulation: Theory and Policy
73-420 Monetary Theory and Policy
79-329 Sex, Population, and Birth Control
79-335 Drug Use and Drug Policy
79-337 Educational Policy in Historical Perspective
80-321 Causation and Social Policy
80-346 Value, Fact, & Policy
88-202 History of Public Policy in the United States
88-346 Environmental History and Politics Since Silent Spring
88-358 Policy Making Institutions
88-412 Economics of Global Warming
88-444 Public Policy and Regulation

2. Management

70-332 Business and Society
70-342 Managing Across Cultures
70-430 International Management
80-241 Ethical Judgments in Professional Life
80-242 Conflict and Dispute Resolution
80-243 Business Ethics
80-244 Environmental Ethics
80-344 Management, Environment, and Ethics
88-341 Organizational Communication
88-343 Economics of Technological Change
88-360 Behavioral Economics
88-385 Managerial Decision Making
88-387 Social Norms and Economics

3. Technology and Information

19-402 Telecommunications Policy
19-448 Science, Technology and Ethics
73-474 The Economics of Ideas: Growth, Innovation, and Intellectual Property
79-230 Technology in American Society
79-340 History of Modern Warfare
79-342 Introduction to Science and Technology Studies
80-341 Computers, Society, and Ethics
88-343 Economics of Technological Change
88-345 Perspectives on Industrial Research and Development
88-347 Complex Technological Systems: Past, Present and Future
88-371 Entrepreneurship, Technological Change, and Regulation
88-391 Technology and Economic Growth

4. International Policy

- 79-278 China’s Environmental Crisis
- 88-378 International Economics
- 88-370 African Politics
- 88-384 Conflict and Conflict Resolution in International Relations
- 88-410 The Global Economy: A User’s Guide
- 88-411 The Rise of the Asian Economies
- 88-412 Economics of Global Warming

5. Political Science and Law

- 70-364 Business Law
- 70-365 Intl Trade and Intl Law
- 80-235 Political Philosophy
- 80-242 Conflict and Dispute Resolution
- 88-181 Topics in Law: 1st Amendment*
- 88-184 Topics in Law: The Bill of Rights*
- 88-202 History of Public Policy in the United States
- 88-346 Environmental History and Politics Since Silent Spring
- 88-358 Policy Making Institutions
- 88-444 Public Policy and Regulation

*only one course (either 88-181 or 88-184) may count toward an elective requirement in the Policy and Management major.

NOTE: Some courses have additional prerequisites.

Policy and Management, B.S.

Sample Curriculum*

Freshman or Sophomore Year	Junior Year	
	Spring	Fall
		Spring
36-202 Statistical Methods	Policy Analysis I 88-220	Policy Analysis II 88-221
Open Prerequisite	Organizations 88-260	Empirical Research Methods 88-251
Open Prerequisite	Elective	Decision Analysis & Decision Support Systems 88-223
Elective	Elective	Elective
Elective	Elective	Elective

Senior Year	
Fall	Spring
Policy Analysis III 88-222 or P&M Elective	Policy Analysis III 88-222 or P&M Elective
Policy and Management Elective	Policy and Management Elective
Policy and Management Elective	Policy and Management Elective
Elective	Elective
Elective	Elective

*This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years; not that it must be. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the first year. Students should consult their advisor when planning their program. Students who are planning to study abroad or to apply for the Heinz Accelerated Masters Program will have a very different curriculum map and should consult early—and often—with the Academic Advisor.

Additional Major

Students who elect Policy and Management as an additional major must fulfill all of the requirements of the Policy and Management major.

Students pursuing Decision Science with an additional major in Policy and Management may only count 36-202, 88-220, 88-223, and 88-251 toward the completion of both majors.

Students pursuing Global Politics with an additional major in Policy and Management may only count 36-202, 88-220, 88-221, and 88-251 toward the completion of both majors.

Additional majors cannot count menu electives toward simultaneously fulfilling more than one major or minor. Students who are interested in an additional major in Policy and Management should see the Academic Advisor of the Policy and Management program.

The Minor in Decision Science

Baruch Fischhoff, Faculty Director
 Office: Porter Hall 219E
 Connie Angermeier, Academic Advisor
 Office: Porter Hall 208A

The minor in Decision Science provides students with a selective survey of disciplinary perspectives. The courses present descriptive and normative approaches to judgment and decision making, as well as some application of theories and results to real-world problems. Students who elect Decision Science as a minor must complete the four core courses (below) and two electives from the elective set (below).

Curriculum 54 units
 Core Courses 36 units

- 88-120 Reason, Passion, and Social Cognition
- 88-220 Policy Analysis I
- 88-223 Decision Analysis and Decision Support Systems
- 88-302 Behavioral Decision Making

Elective Courses 18 units

Complete any two courses from the following categories.

1. Biological and Behavioral Aspects of Decision Making

- 85-219 Biological Foundations of Behavior
- 85-241 Social Psychology
- 85-352 Evolution Psychology
- 85-355 Introduction to Cognitive Neuroscience
- 85-414 Cognitive Neuropsychology
- 85-442 Health Psychology
- 88-307 Irrationality
- 88-360 Behavioral Economics
- 88-377 Attitudes and Persuasion
- 88-386 Desires and Decisions
- 88-407 Health Risk Communication

Appropriate courses offered by the Department of Neuroscience at the University of Pittsburgh (available during the academic year through cross-registration) may also be included as part of this option. Contact the Decision Science faculty director for more information.

2. Managerial and Organizational Aspects of Decision Making

- 70-332 Business, Society and Ethics
- 70-381 Marketing
- 70-481 Marketing Research
- 88-221 Policy Analysis II
- 88-222 Policy Analysis III
- 88-341 Organizational Communication
- 88-444 Public Policy & Regulation

3. Philosophical and Ethical Perspectives on Decision Making

- 19-426 Environmental Decision Making
- 80-208 Critical Thinking
- 80-241 Ethical Judgments in Professional Life
- 80-242 Conflict, Dispute Resolution
- 80-271 Philosophy and Psychology
- 80-305 Rational Choice
- 80-321 Causation and Social Policy
- 80-340 Environmental Ethics and Decision Making
- 80-346 Value Fact and Policy

4. Economic and Statistical and Methods for Decision Science

73-325	Strategic Behavior in Non-cooperative Games
73-347	Game Theory for Economists
73-435	Economics of Negotiations
80-316	Causation Probability & AI
80-405	Game Theory*
88-316	Game Theory*
88-360	Behavioral Economics
88-387	Social Norms and Economics

*80-405 and 88-316 are different courses and are not cross-listed.

5. Research Methods for Decision Science

36-303	Sampling, Survey and Society
36-310	Fundamentals of Statistical Modeling
80-330	Research Ethics
85-340	Research Methods in Social Psychology

Note: Some courses have additional prerequisites.

The Minor in Global Politics

Kiron K. Skinner, Faculty Director
Office: Porter Hall 223H
Traci E. Sebastian, Academic Advisor
Office: Baker Hall A60C

The minor in Global Politics introduces students to the study of global and international relations through the lens of analytical social science. Through a combination of core courses and electives, students will become conversant not only in the fundamental theories and concepts of global and international relations, but also in analytical tools that can help to understand, assess, and predict the behavior of actors within the global political system.

Curriculum**54 units****Required Courses****27 units**

88-104	Decision Processes in American Political Institutions
88-205	Comparative Politics
88-326/	
79-350	Theories of International Relations

Electives**27 units**

Students will select three courses from the following categories, with one course from each category. At least one of these courses (9 units) must be from the Department of Social and Decision Sciences (88-xxx). Most courses listed below are 9-unit courses, but some are fewer. When courses offered for fewer than 9 units are chosen, students should note that a minimum of 27 units is required, and should plan to take one or more additional courses as appropriate.

1. International Political Economy

70-365	International Trade and International Law
70-430	International Management
73-371	International Trade and Economic Development
73-372	International Money and Finance
79-301	African Entrepreneurs/Entrepreneurs in Africa: Past, Present, and Future
80-136	Social Structure, Public Policy and Ethical Dilemmas
80-244	Environmental Ethics
80-340	Management, Environment and Ethics
80-348	Health, Development, and Human Rights
80-447	Global Justice
88-378	International Economics
88-410	The Global Economy: A User's Guide
88-411	The Rise of the Asian Economies

2. International Politics

88-329/	
79-231	American Foreign Policy
88-357	Comparative Foreign Policy
88-358	Policy Making Institutions
88-359	Globalization
88-370	African Politics
88-384	Conflict and Conflict Resolution in International Relations

3. International Cultures

300-level language course

70-342	Managing Across Cultures
76-318	Communicating in the Global Marketplace
76-322	Global Masala: South Asians in the Diaspora
76-449	Culture and Globalization
79-205	20th Century Europe
79-212	Disastrous Encounters: Technology and the Environment in Global Historical Context
79-233	The US and Middle East Since 1945
79-248	History and Theory of Property
79-258	Introduction to African History
79-260	Mayan America
79-263	From Soil to Oil: Energy, Ecology, and Globalization
79-264	China's Neighbors
79-271	Modern China
79-276	North of the Border: Mexican Immigration Past and Present
79-278	China's Environmental Crisis
79-281	Russian History: From Communism to Capitalism
79-288	Bananas, Baseball, and Borders: A History of Latin America-US Relations
79-290	Between Revolutions: The Development of Modern Latin America
79-294	The Marking of the African Diaspora in the New World
79-295	Germany and World War II
79-307	The Anthropology of Europe
79-314	Nationalities and the New States of the Former USSR
79-336	Epidemic Disease and Public Health
79-340	History of Modern Warfare
79-342	Introduction to Science and Technology Studies
79-352	The Arab-Israeli Condition: War and Peace
79-380	Experiencing Globalization
79-397	Religion and Politics in the Middle East
82-304	Francophone World
82-323	Germany, Austria and Switzerland in the 20th Century
82-324	Contemporary Germany, Austria and Switzerland
82-325	Introduction to German Studies
82-333	Introduction to Chinese Language and Culture
82-342	Spain: Language and Culture
82-343	Latin America: Language and Culture
82-345	Introduction to Hispanic Literary and Cultural Studies
82-404	Francophone Realities: Africa
82-424	New Germany
82-431	China and the West
82-432	Popular Culture in China
82-441	Studies in Peninsular Literature and Culture
82-451	Studies in Latin American Literature and Culture
82-455	Topics in Hispanic Studies
82-474	Topics in Japanese Studies

NOTE: Some courses have additional prerequisites.

The Minor in Innovation, Entrepreneurship, and Economic Development

John H. Miller, Faculty Director
Office: Porter Hall 208D
Traci E. Sebastian, Academic Advisor
Office: Baker Hall A60C

The pace of technological change has been steadily increasing over the last 100 to 200 years, if not longer. The ability of nations to grow and prosper economically is dependent on their ability to harness the forces of technological change. Today it is common to speak of the knowledge economy in which the success of firms depends on their ability to manage innovation and technological change. Regions all aspire to be the next Silicon Valley and enact all kinds of policies to lure and support innovative firms. Technological change pervades our lives, entering nearly every decision we make. The goal of the minor in Innovation, Entrepreneurship, and Economic Development is to equip students to understand the forces underlying and unleashed by technological change in order to become better decision-makers, managers, policy analysts, and researchers.

The minor has been created to service students that are interested in entrepreneurship, the management of innovation, economic development, and technology policy. The minor is available to undergraduate students in all colleges. This interdisciplinary and interdepartmental minor, composed of courses offered in various departments and colleges throughout the university, is offered through the Global and International Relations Program in the College of Humanities and Social Sciences.

In order to complete the minor, students must take six courses: two core courses, and four electives. At most one of these courses may double-count with another major or minor.

Curriculum 54 units

Required Courses 18 units

At least two of the courses must come from the following list of core courses:

19-605/88-714	Science, Technology, and Innovation Policy
19-613	Industries and Technological Innovation
19-682/90-880	The Strategy and Management of Technological Innovation
79-440/88-345	Perspectives on Industrial Research and Development
88-371	Entrepreneurship, Technological Change, and Regulation in Theory and Practice
88-391/90-756	Technology and Economic Growth
88-410/90-749	The Global Economy: A User's Guide
88-411/90-752	The Rise of the Asian Economies

Electives 36 units

The other four required courses can come from the above list of core courses or the following courses that were developed in whole or part for the minor:

05-320	The Social Web: Content, Communities, and Context
08-463	Service Innovation
15-502	Technology and Global Development
17-645	Technology Innovation, Adoption and Diffusion
19-484/ 24-484	Decision Tools for Engineering Design and Entrepreneurship
60-387	Art as Business/Business as Art
79-301	African Entrepreneurs, Entrepreneurs in Africa: Past, Present, and Future
90-811	Social Innovation, Social Enterprise, Social Change (this is a mini course and counts as one half of a course)
90-845	Social Enterprise Incubator (this has been a mini course and if it remains so it will count as one-half of a course)
90-858	Microfinance and Development (this is a mini course and counts as one half of a course)

Students can also nominate up to two courses outside of the above two lists to qualify toward the six courses required for the minor. These courses must be directly relevant to the minor. A student must submit and have approved a petition for a course outside the above lists to qualify for the minor.

NOTE: Some courses have additional prerequisites.

The Minor in Policy and Management

Paul Fischbeck, Faculty Director
Office: Porter Hall 208F
Connie Angermeier, Academic Advisor
Office: Porter Hall 208A

Regardless of major, many Carnegie Mellon graduates will face managerial challenges and responsibilities in their professional lives. Whether these are in their area of expertise or in more general settings, these roles will to some degree require assumption of the responsibility for directing the work of others. The Policy and Management minor is intended for students who expect to need these management concepts and skills.

Curriculum 54 units

Required Courses 36 units

88-220	Policy Analysis I
88-221	Policy Analysis II
88-223	Decision Analysis and Decision Support Systems
88-260	Organizations

Electives 18 units

Complete two courses from the following categories.

At least one of the courses (9 units) must be a Social and Decision Sciences course (88-xxx).

1. Policy Making

73-340	Labor Economics
73-352	Public Economics
73-357	Regulation: Theory and Policy
73-420	Monetary Theory and Policy
79-329	Sex, Population, and Birth Control
79-335	Drug Use and Drug Policy
79-337	Educational Policy in Historical Perspective
80-321	Causation and Social Policy
80-346	Value, Fact, & Policy
88-202	History of Public Policy in the United States
88-346	Environmental History and Politics Since Silent Spring
88-358	Policy Making Institutions
88-412	Economics of Global Warming
88-444	Public Policy and Regulation

2. Management

70-332	Business and Society
70-342	Managing Across Cultures
70-430	International Management
80-241	Ethical Judgments in Professional Life
80-242	Conflict and Dispute Resolution
80-243	Business Ethics
80-244	Environmental Ethics
80-344	Management, Environment, and Ethics
88-341	Organizational Communication
88-343	Economics of Technological Change
88-360	Behavioral Economics
88-385	Managerial Decision Making
88-387	Social Norms and Economics

3. Technology and Information

19-402	Telecommunications Policy
19-448	Science, Technology and Ethics
73-474	The Economics of Ideas: Growth, Innovation, and Intellectual Property
79-230	Technology in American Society
79-340	History of Modern Warfare
79-342	Introduction to Science and Technology Studies
80-341	Computers, Society, and Ethics
88-343	Economics of Technological Change
88-345	Perspectives on Industrial Research and Development
88-347	Complex Technological Systems: Past, Present and Future
88-371	Entrepreneurship, Technological Change, and Regulation
88-391	Technology and Economic Growth

4. International Policy

79-278	China's Environmental Crisis
88-378	International Economics
88-370	African Politics
88-384	Conflict and Conflict Resolution in International Relations
88-410	The Global Economy: A User's Guide
88-411	The Rise of the Asian Economies
88-412	Economics of Global Warming

5. Political Science and Law

70-364	Business Law
70-365	Intl Trade and Intl Law
80-235	Political Philosophy
80-242	Conflict and Dispute Resolution
88-181	Topics in Law: 1st Amendment*
88-184	Topics in Law: The Bill of Rights*
88-202	History of Public Policy in the United States
88-346	Environmental History and Politics Since Silent Spring
88-358	Policy Making Institutions
88-444	Public Policy and Regulation

*only one course (either 88-181 or 88-184) may count toward an elective requirement in the Policy and Management minor.

NOTE: Some courses have additional prerequisites.

Faculty

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Department of Statistics

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Uncertainty is inescapable: randomness, measurement error, deception, and incomplete or missing information complicate all our lives. Statistics is the science and art of making predictions and decisions in the face of uncertainty. Statistical issues are central to big questions in public policy, law, medicine, industry, computing, technology, finance, and science. Indeed, the tools of Statistics apply to problems in almost every area of human activity where data are collected.

Statisticians must master diverse skills in computing, mathematics, decision making, forecasting, interpretation of complicated data, and design of meaningful comparisons. Moreover, statisticians must learn to collaborate effectively with people in other fields and, in the process, to understand the substance of these other fields. For all these reasons, Statistics students are highly sought-after in the marketplace.

Recent Statistics majors at Carnegie Mellon have taken jobs at leading companies in many fields, including Intel, Procter and Gamble, Price Waterhouse-Coopers, D.E. Shaw, Harvard Management Company, and Marketing and Planning Systems. Other students have been taken research positions at the National Security Agency, the Census Bureau, and internships at the Joint Program in Survey Methodology in Washington D.C. and the Epidemiology Data Center at the University of Pittsburgh. Many of our students have also gone on to graduate study at some of the top programs in the country, including Statistics at Carnegie Mellon, Yale, and the University of Washington; Biostatistics at Michigan, Harvard and Johns Hopkins; Industrial Engineering at Stanford; Operations Research at Penn State; and Clinical Psychology and Neuroscience at the University of Pittsburgh.

The Department and Faculty

The Department of Statistics at Carnegie Mellon University is world-renowned for its contributions to statistical theory and practice. Research in the department runs the gamut from pure mathematics to the hottest frontiers of science. Current research projects are helping make fundamental advances in neuroscience, cosmology, seismology, finance, and genetics.

The faculty members are recognized around the world for their expertise and have garnered many prestigious awards and honors. (For example, three members of the faculty have been awarded the COPSS medal, the highest honor given by professional statistical societies.) At the same time, the faculty is firmly dedicated to undergraduate education. The entire faculty, junior and senior, teaches courses at all levels, including the introductory courses. The faculty are accessible and are committed to involving undergraduates in research.

The Department augments all these strengths with a friendly, energetic working environment and exceptional computing resources. Talented graduate students join the department from around the world, and add a unique dimension to the department's intellectual life. Faculty, graduate students, and undergraduates interact regularly.

How to Take Part

There are many ways to get involved in Statistics at Carnegie Mellon:

- The Bachelor of Science in Statistics in the College of Humanities and Social Sciences (H&SS) is a broad-based, flexible program that helps you master both the theory and practice of Statistics. The program can be tailored to prepare you for later graduate study in Statistics or to complement your interests in almost any field, including Psychology, Physics, Biology, History, Business, Information Systems, and Computer Science.
- The Minor (or Additional Major) in Statistics is a useful

complement to a (primary) major in another Department or College. Almost every field of inquiry must grapple with statistical problems, and the tools of statistical theory and data analysis you will develop in the Statistics minor will give you a critical edge.

- The Bachelor of Science in Economics and Statistics provides an interdisciplinary course of study aimed at students with a strong interest in the empirical analysis of economic data. Jointly administered by the Department of Statistics and the Undergraduate Economics Program, the major's curriculum provides students with a solid foundation in the theories and methods of both fields. (See H&SS Interdepartmental Majors as well as later in this section)
- The Statistical and Mathematical Sciences Program (within the Science and Humanities Scholars Program), is an alternative path for the study of Statistics that is jointly administered by the Department of Mathematical Sciences and the Department of Statistics.
- The Statistics Concentration within the Mathematical Sciences Major (see Department of Mathematical Sciences) is jointly administered by the Department of Mathematical Sciences and the Department of Statistics.
- Many exciting Research Projects are ongoing in the Statistics Department, and the department enthusiastically seeks to involve undergraduates in this work. Both majors and non-majors are welcome.
- Non-majors are eligible to take most of our courses, and indeed, they are required to do so by many programs on campus. Such courses offer a good way to get involved in cutting-edge research within the Statistics Department.

Curriculum

Statistics consists of two intertwined threads of inquiry: Statistical Theory and Data Analysis. The former uses probability theory to build and analyze mathematical models of data in order to devise methods for making effective predictions and decisions in the face of uncertainty. The latter involves techniques for extracting insights from complicated data, designs for accurate measurement and comparison, and methods for checking the validity of theoretical assumptions. Statistical Theory informs Data Analysis and vice versa. The Statistics Department curriculum follows both of these threads and helps the student develop the complementary skills required.

Below, we describe the requirements for the Major in Statistics and the different categories within our basic curriculum. This is followed by the requirements for the Minor in Statistics and the requirements for the Major in Economics and Statistics.

Note: We recommend that you use the information provided below as a general guideline, and then schedule a meeting with the Statistics Undergraduate Advisor, Oded Meyer (meyer@stat.cmu.edu) to discuss the requirements in more detail, and build a program that is tailored to your strengths and interests.

The Major in Statistics

(B.S. in Statistics)

Students in the Bachelor of Science program develop and master a wide array of skills in computing, mathematics, statistical theory, and the interpretation and display of complex data. In addition, Statistics majors gain experience in applying statistical tools to real problems in other fields and learn the nuances of interdisciplinary collaboration. The requirements for the Major in Statistics are detailed below and are organized by categories #1-#6.

1. Mathematical Foundations (Prerequisites): 28-29 units

Mathematics is the language in which statistical models are described and analyzed, so some experience with basic calculus and linear algebra is an important component for anyone pursuing a program of study in Statistics.

Calculus*:

Complete *one* of the following three sequences of mathematics courses at Carnegie Mellon, each of which provides sufficient preparation in calculus:

Sequence 1

21-111 Calculus I
21-112 Calculus II

Sequence 2

21-120 Differential and Integral Calculus
21-122 Integration, Differential Equations and Approximation

Sequence 3

21-120 Differential and Integral Calculus
21-256 Multivariate Analysis and Approximations

Note: Other sequences are possible, and require approval from the undergraduate advisor.

Linear Algebra**:

Complete *one* of the following two mathematics courses at Carnegie Mellon each of which provides sufficient preparation in linear algebra:

21-241 Matrix Algebra
21-341 Linear Algebra I ***

* It is recommended that students complete the calculus requirement during their freshman year.

** The linear algebra requirement needs to be completed before taking 36-401

*** A more mathematically rigorous course and usually taken only by mathematics majors

2. Data Analysis: 45 units

Data analysis is the art and science of extracting insight from data. The art lies in knowing which displays or techniques will reveal the most interesting features of a complicated data set. The science lies in understanding the various techniques and the assumptions on which they rely. Both aspects require practice to master.

The *Beginning Data Analysis* courses give a hands-on introduction to the art and science of data analysis. The courses cover similar topics but differ slightly in the examples they emphasize. 36-201 draws examples from many fields and satisfies the H&SS College Core Requirement in Statistical Reasoning. It is therefore the recommended course for students in the College. (Note: A score of 5 on the Advanced Placement (AP) Exam in Statistics may be used to waive this requirement). Other courses emphasize examples in business (36-207), engineering and architecture (36-220), and the laboratory sciences (36-247).

The *Intermediate Data Analysis* courses build on the principles and methods covered in the introductory course, and more fully explore specific types of data analysis methods in more depth.

The *Advanced Data Analysis* courses draw on students' previous experience with data analysis and understanding of statistical theory to develop advanced, more sophisticated methods. These core courses involve extensive analysis of real data and a substantial component of independent research.

Beginning*

Choose *one* of the following courses

36-201 Statistical Reasoning and Practice
36-207 Probability and Statistics for Business Applications
36-220 Engineering Statistics and Quality Control
36-247 Statistics for the Laboratory Sciences

* Students who enter the program through 36-225 or 36-226 (like math or CS majors choosing statistics as an additional major), usually skip the beginning data analysis course and take an additional statistics elective instead (see category #5, Statistical Electives, below)

Intermediate

Choose *one* of the following courses

36-202 Statistical Methods
36-208 Regression Analysis (cross listed as 70-208)
36-309 Experimental Design for Behavioral and Social Sciences

Advanced

Choose *one* of the following three courses:

36-303 Sampling, Surveys, and Society
36-315 Statistical Graphics and Visualization
36-350 Data Mining

and take the following *two* courses

36-401 Modern Regression
36-402 Advanced Data Analysis

3. Probability Theory and Statistical Theory: 9 or 18 units

The theory of probability gives a mathematical description of the randomness inherent in our observations. It is the language in which statistical models are stated, so an understanding of probability is essential for the study of statistical theory. Statistical theory provides a mathematical framework for making inferences about unknown quantities from data. The theory reduces statistical problems to their essential ingredients to help devise and evaluate inferential procedures. It provides a powerful and wide-ranging set of tools for dealing with uncertainty.

The Statistics Department offers three options for satisfying the theory requirement. The options are given below and are followed by a set of comments which explain the difference between the options and provide general guidelines about choosing among them. The final choice, however, should be made in consultation with the Undergraduate Advisor of the Statistics Department.

Option 1:

Take the following course:

36-310 Fundamentals of Statistical Modeling

Option 2:

Take the following theory sequence :

36-225* Introduction to Probability and Statistics I
36-226 Introduction to Probability and Statistics II

* It is possible to substitute 36-217 or 21-325 for 36-225. (36-225 is the standard introduction to probability, 36-217 is tailored for engineers and computer scientists, and 21-325 is a rigorous Probability Theory course offered by the Department of Mathematics.)

Option 3:

Take the following theory sequence :

36-625 Probability and Mathematical Statistics I
36-626 Probability and Mathematical Statistics II

Comments:

(i) Students who take option 1 will learn probability theory in the first part of the course 36-310 and statistical theory in the second part of the course. In options 2 and 3, students take a full course in probability theory followed by a full course in statistical theory.

(ii) Option 1 is intended for students with less experience in mathematics and probability and provides a conceptual bridge between data analysis methods and the theory underlying them. Options 2 and 3 cover the theory in greater depth and with more

mathematical content for students who are concentrating in technical fields. Option 3 is much more mathematically rigorous and is good preparation for later graduate work in Statistics or other disciplines.

(iii) The vast majority of students are advised to choose among Option 1 or Option 2. Statistics Majors who are also majoring in Computer Science, Operations Research, or Mathematics or who are considering graduate study in Statistics should carefully consider (in consultation with the Undergraduate Advisor) taking Option 3 in order to satisfy their Theory requirement.

(iv) Students who take Option 2 or Option 3, can use the first course in the sequence (i.e., 36-225 or 36-625), to satisfy the "Elective Within Statistics Requirement" (see the Statistical Electives category).

(v) **Important:** In order to be a Major or a Minor in good standing, a grade of at least a C is required in 36-310 (Option 1) or in 36-226 (Option 2). In particular, this is required in order to be able to continue to senior level courses.

4. Special Topics: 9 units

The Statistics Department offers seminar courses that focus on specific statistical applications or advanced statistical methods. At least one of these courses (36-461) will be offered every year (usually in the Fall); the other (36-462) is offered intermittently according to interest and demand. Past topics included statistics and the law, Bayesian statistics, non-parametric statistics, statistical genetics, and statistical methods in epidemiology. The objective of the seminar course is to expose students to important topics in statistics and/or interesting applications which are not part of the standard undergraduate curriculum.

Choose *one* of the following courses:

36-461	Topics in Statistics
36-462	Topics in Statistics

5. Statistical Electives: 9 or 18 units*

Statistical electives courses can be either within or outside the statistics department. Students are required to take *two* electives, *only one* of which can be outside statistics.

* Students who take Option 2 or 3 in the Theory requirement (see Category 3 above), can use the first course in the theory sequence as an elective within statistics and therefore are required to take only one additional elective which can be either within or outside statistic.

Courses within Statistics

Any course in Probability Theory, Advanced Data Analysis, or Special Topics categories that does not satisfy any other requirement for a Statistics Major may be counted as a Statistical Elective.

Courses outside Statistics

The following is a partial list of courses that qualify as electives as they provide intellectual infrastructure that will advance the student's understanding of statistics and its applications. Other courses may qualify as well; consult with the Statistics Undergraduate Advisor.

15-100	Introductory/Intermediate Programming
15-111	Intermediate/Advanced Programming
15-200	Advanced Programming/Practicum
21-127	Concepts of Mathematics
21-259	Calculus in Three Dimensions
21-260	Differential Equations
21-292	Operations Research I
21-301	Combinatorial Analysis
80-220	Philosophy of Science
80-221	Philosophy of Social Science
80-222	Philosophy of Economics
80-310	Logic and Computability I
85-310	Research Methods in Cognitive Psychology
85-340	Research Methods in Social Psychology
88-223	Decision Analysis and Decision Support Systems
88-302	Behavioral Decision Making

Note: Additional prerequisites are required for some of these courses. Students should carefully check the course descriptions to determine if additional prerequisites are necessary.

6. Concentration Area: 36 units*

The power of Statistics, and much of the fun, is that it can be applied to answer such a wide variety of questions in so many

different fields. A critical part of statistical practice is understanding the questions being asked so that appropriate methods of analysis can be used. Hence, a critical part of statistical training is to gain experience applying the abstract tools to real problems. The Concentration Area is a set of four related courses outside of Statistics that prepares the student to deal with statistical aspects of problems that arise in another field. These courses are usually drawn from a *single* discipline of interest to the student and are chosen in consultation with the Statistics Undergraduate Advisor. For example, students intending to pursue careers in public policy could take further courses in History or Economics, students intending to pursue careers in the health or biomedical sciences could take further courses in Biology or Chemistry, and students intending to pursue graduate work in Statistics could take further courses in advanced Mathematics.

* Note: This requirement is only for students whose primary major is statistics with no other additional major or minor. Double majors usually satisfy this requirement by default (see "Additional Majors" section below)

Total Number of Units for the Major: 145*

Total Number of Units for the Degree: 360

*Note:

This number can vary since, for example, it includes the 36 units of the "Concentration Area" category which may not be required (see category 6 above for details).

Recommendations

Students in the College of Humanities and Social Sciences who wish to major or minor in Statistics are advised to complete both the calculus requirement (one Mathematical Foundations calculus sequence) and the Beginning Data Analysis course 36-201 (Statistical Reasoning and Practice) by the end of their Freshman year.

The linear algebra requirement is a prerequisite for the course 36-401. It is therefore essential to complete this requirement during your junior year at the latest!

Statistics Majors who are also majoring in Computer Science, Operations Research, or Mathematics or who are considering graduate study in Statistics should carefully consider (in consultation with the Undergraduate Advisor) taking Option 3 in order to satisfy their Theory requirement.

Additional Majors

Students who elect Statistics as a second or third major must fulfill all Statistics degree requirements, however, the Concentration Area requirement is usually waived in consultation with the student's advisor. Majors in many other programs would naturally complement a Statistics Major, including Tepper's undergraduate business program, Social and Decision Sciences, Policy and Management, and Psychology.

Students are advised to begin planning their curriculum (with appropriate advisors) as soon as possible. This is particularly true if the other major has a complex set of requirements and prerequisite or when many of the other major's requirements overlap with the requirements for a Major in Statistics

Research

One goal of the Statistics program is to give students experience with statistical research. A wide variety of exciting research projects is ongoing in the department, and students have many opportunities to get involved in a project that interests them.

Before graduation, students will be expected to participate in an independent research project under faculty supervision. Students do this through projects in specific courses, such as 36-303 and 36-402, through an independent study, 36-295, or through a summer research position.

Qualified seniors are also encouraged to participate in an advanced research project or independent study under the supervision of a Statistics faculty advisor. Students earn credit for this work by enrolling in 36-495. Students who maintain a quality point average of 3.25 overall may also apply to participate in the H&SS Senior Honors Program (see relevant section in the catalog for details).

Sample Programs

The following sample programs illustrate two (of many) ways to satisfy the requirements of the Statistics Major. However, keep in mind that the program is flexible enough to support many other possible schedules and to emphasize a wide variety of interests. The first schedule below has a heavier emphasis on data analysis; it includes Mathematical Foundations Sequence 1 and 15-127 as a Statistical Elective outside of Statistics.

The second schedule below has a heavier emphasis on statistical theory and probability; it substitutes an extra Statistical Elective (36-225) for Beginning Data Analysis, and includes Mathematical Foundations Sequence 2.

In both schedules, C.A. refers to Concentration Area courses.

Schedule 1

Year	Fall	Spring
Freshman	36-201 21-111	36-202 21-112
Sophomore	15-127 (elective)	36-303 36-315
Junior	36-310 C.A.	21-241 C.A.
Senior	36-401 36-461 C.A.	36-402 C.A.

Schedule 2

Year	Fall	Spring
Freshman	21-120	21-256
Sophomore	36-225	36-226 21-241
Junior	36-350 36-309 C.A.	36-315 C.A.
Senior	36-401 36-461 C.A.	36-402 36-410 C.A.

The Minor in Statistics

The Minor in Statistics develops skills that complement major study in other disciplines. The program helps the student master the basics of statistical theory and advanced techniques in data analysis. This is a good choice for deepening understanding of statistical ideas and for strengthening research skills.

In order to get a minor in Statistics a student must satisfy the requirements in the first three categories of the Major's requirements. (read the section about the Major in Statistics for details). In other words, the requirements for the minor are:

1. Mathematical Foundation

Calculus: 19-20 units via Sequence 1, 2, or 3

Algebra: 9 units via 21-241 or 21-341

2. Data Analysis

- Beginning Data Analysis

9 units (one course) or Statistical Elective*

- Intermediate Data Analysis

9 units (one course)

- Advanced Data Analysis

27 units: one of 36-303, 36-315, or 36-350 + both 36-401 and 36-402

3. Theory

9-18 units: via Options 1, 2 or 3**.

Total

82 Units

* For students who enter the program with 36-225/226 or 36-625/626, in which case either 36-225 or 36-625 can serve as the elective.

** In order to be a Major or a Minor in good standing, a grade of at least a C is required in 36-310 or in 36-226. (In particular, this is required in order to be able to continue to senior level courses.)

Sample Programs

The following two sample programs illustrates two (of many) ways to satisfy the requirements of the Statistics Minor. Keep in mind that the program is flexible and can support many other possible schedules. The first schedule has a heavier emphasis on data analysis, and is one that would be typically taken by students in the College of Humanities and Social Sciences (such as psychology majors). The second schedule (or similar) is more mathematical, and is suggested, for example, for students who major in Computer Science.

Schedule 1

Year	Fall	Spring
Freshman	21-111 36-201	21-112
Sophomore	36-309	36-303
Junior	36-310	21-241
Senior	36-401	36-402

Schedule 2

Year	Fall	Spring
Freshman	21-120 21-241	21-256
Sophomore	36-225	36-226
Junior	36-309	36-315
Senior	36-401	36-402

The Major in Economics and Statistics (B.S. in Economics and Statistics)

The major in Economics and Statistics provides an interdisciplinary course of study aimed at students with a strong interest in the empirical analysis of economic data. Jointly administered by the Department of Statistics and the Undergraduate Economics Program, the major's curriculum provides students with a solid foundation in the theories and methods of both fields. Students in this major are trained to advance the understanding of economic issues through the analysis, synthesis and reporting of data using the advanced empirical research methods of statistics and econometrics. Graduates are well positioned for admission to competitive graduate programs, including those in statistics, economics and management, as well as for employment in positions requiring strong analytic and conceptual skills – especially those in economics, finance, education, and public policy.

The requirements for the B.S. in Economics and Statistics are the following:

I. Prerequisites 74 Units

1. Writing Prerequisite 9 units

Choose one:

- 73-270 Professional Writing for Economics
- 76-270 Writing in the Professions
- 76-271 Intro to Professional and Technical Writing

2. Mathematical Foundations 38 units

- 21-120 Differential and Integral Calculus
- 21-122 Integration, Diff Equations, and Approximations
- 21-256 Multivariate Analysis and Approximation
- 21-241 Matrix Algebra

3. Economics Foundations 9 units

- 73-100 Principles of Economics

4. Statistical Foundations 18 units

- 36-201 Introduction to Statistical Reasoning and Practice*

and one of the following:

- 36-202 Introduction to Statistical Methods
- 36-208 Regression Analysis (cross listed as 70-208)
- 36-309 Experimental Design for Behavioral & Social Sciences

* Acceptable equivalents for 36-201 are 36-207, 36-220, 36-247, and 70-207.

II. Disciplinary Core 111 units

1. Economics Core 39 units

- 73-150 Microeconomics
- 73-200 Macroeconomics
- 73-252* Advanced Microeconomic Theory
- 73-253* Advanced Macroeconomic Theory
- 73-261 Econometrics

* Mini courses

2. Statistics Core 36 units

- 36-225 Introduction to Probability and Statistics I
- 36-226 Introduction to Probability and Statistics II
- 36-401 Modern Regression
- 36-402 Advanced Data Analysis (Project Course)

3. Economics Electives 18 units

Choose two advanced courses.
(numbered 73-300 through 73-495)

4. Statistics Electives 18 units

Choose two courses at the 36-300 level or above.

Total number of units for the *major* 185 units

Total number of units for the *degree* 360 units

Sample Program

The following sample program illustrates one (of many) ways to satisfy the requirements of the Economics and Statistics Major. Keep in mind that the program is flexible and can support other possible schedules (see comment following the schedule).

Year	Fall	Spring
Freshman	21-120 36-201 ----- ** ----- -----	21-122 36-202 73-150 ----- -----
Sophomore	21-256 36-225 73-200 ----- -----	21-241 36-226 73-252/3 ----- -----
Junior*	36-401 73-261 Writing Req. Econ Elective -----	36-402 Stats Elective ----- ----- -----
Senior	Stats Elective ----- ----- ----- -----	Econ Elective ----- ----- ----- -----

* A student could spend, for example, year 3 abroad and move year 3 courses to year 4.

** In each semester, ----- represents other courses (not related to the major) which are needed in order to complete the 360 units that the degree requires.

Substitutions and Waivers

Many departments require Statistics courses as part of their Major or Minor programs. Students seeking transfer credit for those requirements from substitute courses (at Carnegie Mellon or elsewhere) should seek permission from their advisor in the department setting the requirement. The final authority in such decisions rests there. The Statistics Department does not provide approval or permission for substitution or waiver of another department's requirements.

However, the Statistics Director of Undergraduate Studies will provide advice and information to the student's advisor about the viability of a proposed substitution. Students should make available as much information as possible concerning proposed substitutions. Students seeking waivers may be asked to demonstrate mastery of the material.

Statistics Majors and Minors seeking substitutions or waivers should speak to the Statistics Director of Undergraduate Studies.

Faculty

BERNIE DEVLIN, Adjunct Associate Professor — Ph.D., Pennsylvania State University; Carnegie Mellon, 1994—.

MICHELE DIPIETRO, Instructor and Associate Director, Eberly Center Ph.D., Carnegie Mellon, 2001—.

WILLIAM F. EDDY, John C. Warner Professor of Statistics — Ph.D., Yale University; Carnegie Mellon, 1976—.

STEPHEN E. FIENBERG, University Professor and Maurice Falk Professor of Statistics and Social Sciences — Ph.D., Harvard University; Carnegie Mellon, 1980–1991; 1993—.

CHRISTOPHER GENOVESE, Professor of Statistics — Ph.D., University of California, Berkeley; Carnegie Mellon, 1994—.

JOEL B. GREENHOUSE, Professor of Statistics — Ph.D., University of Michigan; Carnegie Mellon, 1982—.

MATTHEW HARRISON, Visiting Assistant Professor— Ph.D., Brown University; Carnegie Mellon, 2006—.

JIASHUN JIN, Associate Professor— Ph.D., Stanford University; Carnegie Mellon, 2007—.

BRIAN JUNKER, Professor of Statistics — Ph.D., University of Illinois; Carnegie Mellon, 1990—.

ROBERT E. KASS, Professor of Statistics — Ph.D., University of Chicago; Carnegie Mellon, 1981—.

ANN LEE, Assistant Professor — Ph.D., Brown University; Carnegie Mellon, 2005—.

JONG SOO LEE, Visiting Assistant Professor— Ph.D., Rice University; Carnegie Mellon, 2006—.

JOHN P. LEHOCZKY, Thomas Lord Professor of Statistics and Dean of the College of Humanities and Social Sciences — Ph.D., Stanford University; Carnegie Mellon, 1969—.

ODED MEYER, Associate Teaching Professor — Ph.D., University of Pittsburgh; Carnegie Mellon, 1999—.

REBECCA NUGENT, Visiting Assistant Professor — Ph.D., University of Washington; Carnegie Mellon, 2006—.

ALESSANDRO RINALDO, Assistant Professor — Ph.D. Carnegie Mellon; Carnegie Mellon, 2005—.

KATHRYN ROEDER, Professor of Statistics — Ph.D., Pennsylvania State University; Carnegie Mellon, 1994—.

CHAD M. SCHAFER, Assistant Professor — Ph.D., University of California, Berkeley; Carnegie Mellon, 2004—.

MARK J. SCHERVISH, Department Head and Professor of Statistics Ph.D., University of Illinois; Carnegie Mellon, 1979—.

TEDDY SEIDENFELD, Herbert A. Simon Professor of Philosophy and Statistics — Ph.D., Columbia University; Carnegie Mellon, 1985—.

HOWARD SELTMAN, Associate Research Professor — Ph.D., Carnegie Mellon University; Medical College of Pennsylvania — M.D. Carnegie Mellon, 1999—.

COSMA SHALIZI, Assistant Professor — Ph.D. University of Wisconsin, Madison, Carnegie Mellon, 2005—.

SURYA TOKDAR, Visiting Assistant Professor — Ph.D. Purdue University; Carnegie Mellon, 2006—.

VALERIE VENTURA, Associate Research Professor — Ph.D., University of Oxford; Carnegie Mellon, 1997—.

ISABELLA VERDINELLI, Professor in Residence — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1991—.

PANTELIS K. VLACHOS, Associate Teaching Professor — Ph.D., University of Connecticut; Carnegie Mellon, 1996—.

LARRY WASSERMAN, Professor of Statistics — Ph.D., University of Toronto; Carnegie Mellon, 1988—.

Emeritus Faculty

GEORGE T. DUNCAN, Professor of Statistics and Public Policy — Ph.D., University of Minnesota; Carnegie Mellon, 1974—.

JOSEPH B. KADANE, Leonard J. Savage Professor of Statistics and Social Sciences — Ph.D., Stanford University; Carnegie Mellon, 1969—.

The H. John Heinz
III School of
Public Policy and
Management

H. John Heinz III School of Public Policy and Management

Mark Wessel, Dean
Office: 1509 Hamburg Hall
<http://www.heinz.cmu.edu/>

What draws students to the graduate programs of the H. John Heinz III School of Public Policy and Management? Students entering the Heinz School are accomplished, talented and committed to important issues of public interest. At this school, each student gains the skills and knowledge necessary to transform that talent and commitment into a successful career and a positive force for change.

The Heinz School is a dynamic community of scholars and practitioners developing fundamental knowledge about and seeking innovative, applied solutions to today's most critical problems of public policy and management. The degree programs offered at the Heinz School are:

- Master of Science in Public Policy and Management (options include joint and dual degree programs with the Tepper School of Business, a dual degree program with the University of Pittsburgh School of Law and a track that includes one year of study at the main campus in Pittsburgh and one year of study/experimental learning at our location in Washington, DC)
- Master of Arts Management
- Master of Entertainment Industry Management
- Master of Science in Health Care Policy and Management
- Master of Medical Management
- Master of Public Management
- Master of Science in Biotechnology and Management
- Master of Science in Information Security Policy and Management
- Doctor of Philosophy in Public Policy and Management

Distinctive features of the Heinz School include the quality of its research and teaching, and the attention it gives to the needs of its students. The Heinz School educational environment offers:

- An innovative curriculum incorporating analytic rigor; depth of substantive knowledge; applied project work; marketable and transferable skill development; and the integration of policy, technology and management.
- Daily access to faculty members known internationally for expertise in their fields.
- Exposure to cutting-edge technologies and management practices geared toward the needs of the changing organizations pursuing the public interest.
- The flexibility to adapt to the specific interests and career aspirations of students.
- Support for diversity and individual student needs.

The Heinz School programs vary by structure, yet they share a common goal—preparing students for professional positions in which they can help to improve society and the organizations that comprise it.

How is the Heinz School different?

Diversity

The Heinz School student body is nationally recognized for its diversity in ethnicity, gender and citizenship. It also is diverse in terms of students' academic backgrounds, which include undergraduate degrees in architecture, biology, business administration, computer science, economics, education, engineering, English, fine arts, government, history, information systems, philosophy, political science, sociology and many other fields.

Practical Experience

The Heinz School doesn't just teach skills in the classroom. Students work in teams to analyze and develop solutions for current international, national and local problems and present their findings to the officials who have responsibility for addressing those problems. Students take a paid summer internship to practice the skills they've learned in school.

Impact on Society

The expertise of a renowned faculty is transferred to society through the education and research mission of the Heinz School, as well as the efforts of its policy and research centers. These include the National Consortium on Violence Research, Institute for the Study of Information Technology and Society, the Center for Economic Development, the Arts and Culture Observatory and the Center for Arts Management and Technology. Heinz School students can work on projects initiated in these centers or as research assistants for center faculty.

Options for Carnegie Mellon Undergraduates

The Heinz School does not offer undergraduate degrees. It does offer two study options, however, for students pursuing Carnegie Mellon undergraduate degrees – 1) Accelerated Master's Program (AMP), and 2) undergraduate minor in Health Care Policy and Management.

Accelerated Master's Program (3–1–1 Track)

Through the Heinz School Accelerated Master's Program (AMP), exceptional Carnegie Mellon undergraduate students can earn their master's degree, along with their undergraduate degree, in less time than it would take to earn each degree separately. For example, a Carnegie Mellon student could earn an undergraduate degree and a Master of Science or Master of Arts Management degree in five years of study. In the AMP program, students take their undergraduate course load during their first three years, a combination of Heinz School courses and undergraduate courses in their fourth year, and finish their master's degree in their fifth year of study.

Students admitted to the AMP program register for their final undergraduate year at Carnegie Mellon as undergraduates, pay undergraduate tuition, and receive undergraduate financial aid. They enroll in courses required for their B.A./B.S. degree and also take courses toward their Heinz School degree. They receive their B.A./B.S. degree at the end of the fourth year. For the fifth year, they register as Heinz School graduate students, pay graduate tuition, and receive graduate financial aid, if eligible.

The 3–1–1 track is available for the following Heinz programs:

- Public Policy and Management (MSPPM)
- Arts Management (MAM)
- Health Care Policy and Management (HCPM)
- Biotechnology and Management (MSBTM)
- Information Systems Management (MISM)

Additional information can be found on our website: <http://www.heinz.cmu.edu/academics/default.html>

Undergraduate Minor in Health Care Policy and Management

The minor in health care policy and management is offered jointly by the Heinz School, the College of Humanities and Social Sciences, and the Mellon College of Science. The minor is designed to provide students considering a career in the health industry with an understanding of the ways in which social, political, managerial and economic changes are transforming the face of health care, and the roles of organizations and individuals that provide it. Students will become familiar with the critical policy and management issues and will begin to learn to operate effectively in the ever-changing health care environment. The curriculum integrates economic, organizational, managerial, historical, and psychological perspectives, providing a solid foundation for the student.

Curriculum: 60 units (minimum)

Prerequisites:

73-100, 88-220, or equivalent.

Required Courses: 33 units

79-384	Medicine and Society (9 units)
90-735	Health Economics (12 units)
90-761	Health Systems (6 units)
90-861	Health Policy I (6 units)

Elective Courses: 27 units

See page 105 for additional information and lists of elective courses.

What kinds of careers do Heinz School graduates pursue?

A Heinz School degree opens doors to a wide range of professional careers in government agencies, nonprofit organizations, consulting firms, arts groups, foundations, private businesses and a host of other organizations. Heinz School graduates can get the kind of interesting, exciting jobs they want, because they have the expertise in policy, management, finance, information systems, and decision-making that employers need.

The Heinz School Ph.D. program in particular prepares qualified students from a variety of academic and professional backgrounds for careers in research, academia, government-related organizations and the private sector, in positions where expertise in advanced research is desired. Graduates of the Ph.D. program work as professors, research scientists, research directors and consultants, across diverse areas of public service and management.

Some of the jobs that have been held by Heinz School graduates include:

- Budget Analyst, Congressional Budget Office
- President/Chief Executive Officer, Urban League of Philadelphia
- Vice President, Public Finance Division, Donaldson, Lufkin & Jenrette Securities Corp.
- Executive Director, Allegheny Conference on Community Development
- Executive Director, Maryland Small Business Development Financing Authority
- District Manager, AT&T Consumer Information
- Senior Consultant, Ernst and Young
- Director of Marketing, Bardavon 1869 Opera House, Poughkeepsie, NY
- Consultant, Hill Arts and Entertainment
- Special Projects Coordinator, Washington Very Special Projects

The Faculty

Heinz School faculty members have been recognized nationally and internationally for their accomplishments in research and their contributions to public policy. Their backgrounds are in economics, operations research, information systems and technology, fine arts, sociology, public policy, statistics, organizational management and behavior, finance, statistics, labor relations, and demography among other areas. Following is information on many full-time Carnegie Mellon faculty members who teach and do research at the Heinz School. For a more complete, current list, visit www.heinz.cmu.edu/researchers/faculty/.

ACQUISTI, ALESSANDRO, Assistant Professor of Information Systems and Public Policy — Ph.D., UC Berkeley; Carnegie Mellon, 2003 — .

ANWAR, SHAMENA, Assistant Professor of Economics and Public Policy — Ph.D., Yale University; Carnegie Mellon, 2007—.

ARORA, ASHISH, Professor of Economics and Public Policy — Ph.D., Stanford University; Carnegie Mellon, 1991—.

BABCOCK, LINDA, James M. Walton Professor of Economics — Ph.D., University of Wisconsin at Madison; Carnegie Mellon, 1988—.

BARR, EDWARD, Associate Teaching Professor — M.S., Indiana University of Pennsylvania; Carnegie Mellon, 2000—.

BLUMSTEIN, ALFRED, J. Erik Jonsson University Professor of Urban Systems and Operations Research; Director, National Consortium on Violence Research — Ph.D., Cornell University; Carnegie Mellon, 1969—.

BORZUTSKY, SILVIA, Associate Teaching Professor — Ph.D., University of Pittsburgh; Carnegie Mellon, 2001—.

BRANSTETTER, LEE, Associate Professor of Economics — Ph.D., Harvard University; Carnegie Mellon, 2006—.

CALLAN, JAMES, Associate Professor of Computer Science — Ph.D., University of Massachusetts at Amherst; Carnegie Mellon, 1999—.

CAULKINS, JONATHAN, Professor of Operations Research and Public Policy; Faculty Chair, Master of Public Policy and Management Program — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1990—.

CLAY, KAREN, Assistant Professor of Economics and Public Policy — Ph.D., Stanford University; Carnegie Mellon, 1997—.

COHEN, JACQUELINE, Principal Research Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1982—.

COHEN, WESLEY, (Affiliated) Professor of Economics and Social Sciences — Ph.D., Yale University; Carnegie Mellon, 1982—.

DABBISH, LAURA, Assistant Professor of Information Technology and Organizations — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2006—.

EPPLE, DENNIS, (Affiliated) Thomas Lord Professor of Economics — Ph.D., Princeton University; Carnegie Mellon, 1974—.

FARROW, SCOTT, Principal Research Engineer and Director, Center for the Study and Improvement of Regulation — Ph.D., Washington State University; Carnegie Mellon, 1982—.

GAYNOR, MARTIN, E.J. Barone Professor of Economics and Health Policy; Faculty Chair, Ph.D. Program — Ph.D., Northwestern University; Carnegie Mellon, 1995—.

GORR, WILPEN, Professor of Public Policy and Management Information Systems — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1985—.

HAMPSHIRE, ROBERT, Assistant Professor of Operations Research and Public Policy — Ph.D., Princeton University; Carnegie Mellon, 2007—.

HUNKER, JEFFREY, Professor of Technology and Public Policy — Ph.D., Harvard University; Carnegie Mellon, 2001—.

KAMLET, MARK S., Provost, CMU, and H. John Heinz III Professor of Economics and Public Policy — Ph.D., University of California at Berkeley; Carnegie Mellon, 1978—.

KLEPPER, STEVEN, (Affiliated) Professor of Economics and Social Science — Ph.D., Cornell University; Carnegie Mellon, 1980—.

KRACKHARDT, DAVID, Professor of Organizations and Public Policy — Ph.D., University of California at Irvine; Carnegie Mellon, 1991—.

KRISHNAN, RAMAYYA, William W. and Ruth F. Cooper Professor of Management Science and Information Systems; Faculty Chair, Master of Information Systems Management Program — Ph.D., University of Texas at Austin; Carnegie Mellon, 1987—.

KURLAND, KRISTIN, Associate Teaching Professor (joint with School of Architecture) — B.A., University of Pittsburgh; Carnegie Mellon, 1999—.

LAVE, LESTER, James Higgins Professor of Economics and Finance, Professor of Urban and Public Affairs, Professor of Engineering and Public Policy — Ph.D., Harvard University; Carnegie Mellon, 1963—.

LEWIS, GORDON, Associate Professor of Sociology; Faculty Chair, Master of Public Management Program — Ph.D., Stanford University; Carnegie Mellon, 1969—.

LEWIS, PAMELA, Teaching Professor of Professional Speaking — D.A., Carnegie Mellon University; Carnegie Mellon, 1980—.

MADSEN, PETER, Senior Lecturer in Ethics and Public Policy — Ph.D., Duquesne University; Carnegie Mellon, 1988—.

MARINELLI, DONALD, (Affiliated) Professor of Drama and Arts Management (College of Fine Arts) — Ph.D., University of Pittsburgh; Carnegie Mellon, 1984—.

MARTIN, DAN, Director, Master of Arts Management Program, and Associate Professor (College of Fine Arts) — M.F.A., Brooklyn College/City University of New York; Carnegie Mellon, 1993—.

MCCARTHY, MICHAEL, Associate Teaching Professor of Information Systems Management — M.S., University of Pittsburgh; Carnegie Mellon, 1999—.

MERTZ, JOE, Associate Teaching Professor — Ph.D., Carnegie Mellon; Carnegie Mellon, 1994—.

MOORE, KARYN, Assistant Teaching Professor of Information Systems — M.S. Industrial Administration, Carnegie Mellon University; Carnegie Mellon, 2003—.

MORGAN, M. GRANGER, Lord Chair Professor of Engineering and Public Policy, and Head, Department of Engineering and Public Policy — Ph.D., University of California at San Diego; Carnegie Mellon, 1974—.

NAGIN, DANIEL, Theresa and H. John Heinz III Professor of Public Policy, and Research Director, National Consortium on Violence Research — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1979—.

NEILL, DANIEL, Assistant Professor of Information Systems — M.S., University of Pittsburgh; Carnegie Mellon, 2007—.

NYBERG, ERIC, Assistant Professor of Computer Science and Public Policy (joint with School of Computer Science) — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1986—.

PADMAN, REMA, Professor of Operations Research and Information Management; Faculty Chair, Master of Science in Health Care Policy and Management Program — Ph.D., University of Texas at Austin; Carnegie Mellon, 1989—.

PASTOR, LYNNE, Visiting Associate Teaching Professor — M.S. Industrial Administration, Carnegie Mellon University; Carnegie Mellon, 2007—.

ROEHRIG, STEPHEN, Associate Professor of Information Systems and Public Policy — Ph.D., University of Pennsylvania Wharton School; Carnegie Mellon, 1991—.

ROUSSEAU, DENISE, H. J. Heinz II Professor of Organizational Behavior (joint with Graduate School of Industrial Administration)— Ph.D., University of California at Berkeley; Carnegie Mellon, 1994—.

SKINNER, KIRON, (Courtesy) Assistant Professor of History and Political Science — Ph.D., Harvard University; Carnegie Mellon, 1999—.

SMITH, DONALD, Professor of Practice; University Director for Economic Development — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1995—.

SMITH, KATHLEEN, Associate Teaching Professor — Ph.D. candidate, University of Pittsburgh; Carnegie Mellon, 1991—.

SMITH, MICHAEL, Assistant Professor of Information Technology — Ph.D., Alfred P. Sloan School of the Massachusetts Institute of Technology; Carnegie Mellon, 2000—.

STAFFORD, RICHARD, Distinguished Service Professor — M.S. Public Policy and Management, Carnegie Mellon University; Carnegie Mellon, 2005—.

STEPHENS, MELVIN, Assistant Professor of Economics — Ph.D., University of Michigan; Carnegie Mellon, 2000—.

STEWMAN, SHELBY, Professor of Sociology and Demography — Ph.D., Michigan State University; Carnegie Mellon, 1973—.

STRAUSS, ROBERT, Professor of Economics and Public Policy; Faculty Chair, Master of Science in Educational Technology Management Program — Ph.D., University of Wisconsin; Carnegie Mellon, 1979—.

SYNNOTT, LAURA, Associate Teaching Professor, Healthcare Policy and Management — M.S. Health Services Administration, University of Michigan; Carnegie Mellon, 2004—.

SZCZYPULA, JANUSZ, Associate Teaching Professor in Information Systems — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2000—.

TARR, JOEL, Richard S. Caliguiri Professor of Urban and Environmental History and Policy — Ph.D., Northwestern University; Carnegie Mellon, 1967—.

TAYLOR, LOWELL, Professor of Economics and Public Policy; Associate Dean of Faculty — Ph.D., University of Michigan; Carnegie Mellon, 1990—.

TELANG, RAHUL, Assistant Professor of Information Systems — Ph.D., Carnegie Mellon; Carnegie Mellon, 2001.

WESSEL, MARK, Dean, University of Wisconsin; Carnegie Mellon, 1992—.

For further information about the Heinz School, contact:
Director of Admissions
H. John Heinz III School of Public Policy and Management Carnegie Mellon University Pittsburgh, PA 15213
Telephone: (412) 268-2164 Toll-free (U.S.): 1-800-877-3498
Fax: (412) 268-7036
Email: hnzadmit@andrew.cmu.edu
Website: <http://www.heinz.cmu.edu>



Mellon College of Science



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Mellon College of Science

Frederick J. Gilman, Dean
 Eric W. Grotzinger, Associate Dean for Undergraduate Affairs
 Undergraduate Office: Doherty Hall 1324
www.cmu.edu/mcs/

The Mellon College of Science (MCS) has provided the undergraduate training for many of today's leading scientists. We have earned national recognition for our integration of undergraduate education and research from such organizations as the National Science Foundation, the Howard Hughes Medical Institute, and the Beckman Foundation. MCS students gain a broad education in science, mathematics, and the liberal arts while using state-of-the-art computational approaches in their courses, laboratories, and research activities. Our faculty members are committed to teaching as well as to a wide range of scientific research. This combined emphasis on education and research brings special benefits to students, including increased awareness of current scientific developments that are incorporated in classroom instruction, and, most importantly, opportunities to participate with faculty, graduate students, and other research scientists in a variety of research projects.

In the context of rigorous training in each field, the MCS curriculum emphasizes problem-solving, communication, and analytical skills, and it teaches our students the value of hard work and discipline. Our students go on to highly successful careers in a broad range of fields like astrophysics, biotechnology, computer science, business management, environmental science, health care policy, investment banking, marketing analysis, medicine, patent law, and pharmaceuticals. Our alumni credit their education in science for preparing them for a lifetime of learning and achievement; their employers attest to their ability to succeed and to continue learning in an ever-changing world.

The MCS Departments of Biological Sciences, Chemistry, Mathematical Sciences, and Physics each outline their degree programs and courses in the departmental sections. Each program is based on a core of courses required by the college — two semesters each of calculus and physics and one semester each of chemistry, biology, and computer science. These courses lay a broad foundation in the sciences and not only enable our students to choose a major from any of the programs offered in MCS, but also prepare them for exploration of interdisciplinary aspects of science.

Students select their major in the spring of the first year so that the sophomore year begins with a focus within a department. Most of the courses required within a major are scheduled in the sophomore and junior years, leaving much of the senior year and part of the junior year open for electives. This provides the opportunity to participate in undergraduate research, explore interdisciplinary studies, study abroad, pursue additional majors or minors in other fields, or take other specialty courses oriented toward immediate job placement upon graduation or entry into graduate studies.

Tailoring Your Education

The Mellon College of Science offers students tremendous opportunity for tailoring their education to meet individual professional objectives. Whether you target your degree to a particular field in your discipline via departmental options and concentrations, add a secondary major, minor, or degree to your primary degree program, participate in honors programs, or pursue a master's degree along with your bachelor's degree, MCS has much to offer you. Many of these opportunities are outlined below.

Departmental Concentrations

Each department in MCS offers degrees and programs that allow students to explore particular fields within a science discipline. These are outlined below — see the departmental sections for further details.

Biological Sciences

- Biochemistry
- Biophysics
- Cell Biology
- Computational Biology
- Developmental Biology
- Genetics
- Molecular Biology
- Neuroscience

Chemistry

- Biochemistry
- Colloids, Polymers, and Surfaces
- Computational Chemistry
- Environmental Chemistry
- Management
- Material Chemistry
- Polymer Science

Mathematical Sciences

- Computational and Applied Mathematics
- Computational Finance
- Discrete Mathematics and Logic
- Mathematics
- Operations Research
- Statistics

Physics

- Applied Physics
- Astrophysics
- Biological Physics
- Chemical Physics
- Computational Physics

Minors, Double Majors, and Double Degrees

As an MCS student, you can pursue additional majors and minors to complement your primary degree, not only within the science college, but also through the other colleges at Carnegie Mellon. Carnegie Mellon offers many exciting interdisciplinary majors and minors, some of which are listed below. In addition, every college and most departments have designed minors or second majors in their discipline so that you can gain expertise in their fields as well.

Some students choose to gain this expertise by following a double degree program. This results in two distinct bachelor's degrees. Please see the section on Undergraduate Academic Regulations on page 59 for a more formal definition of these "Multiple Degree" programs.

Interdisciplinary Majors and Minors

Here is a sampling of just a few of the interdisciplinary minors and majors offered at Carnegie Mellon. Please see the appropriate sections elsewhere in this catalog for specific descriptions and course requirements.

- Biological Sciences and Psychology Major
- Computational Biology Major
- Engineering Studies Minor
- Environmental Policy Major
- Health Care Policy and Management Minor
- International Affairs Minor
- Robotics Minor
- Scientific Computing Minor
- Technology and Policy Minor

For a complete list of the minors offered at Carnegie Mellon, please see the catalog section on Undergraduate Options on page 77.

Intercollege Programs

MCS participates in two intercollege programs, the Bachelor of Science and Arts Degree program and the Science and Humanities Scholars program. Enrollment for the Science and Humanities program is by invitation only for incoming first-year students, and by application for current students.

Bachelor of Science and Arts Degree Program (BSA)

Students in the Bachelor of Science and Arts Degree program are jointly admitted to MCS and the College of Fine Arts (CFA). This is a degree program for students who are naturally gifted in both the arts and the sciences, and allows for the combining of talents in these areas. See page 90 for details.

Science and Humanities Scholars Program (SHS)

Students in the Science and Humanities Scholars Program (SHS) are jointly admitted to MCS and the College of Humanities and Social Sciences (H&SS). Participants in this program follow a special general education core, but have the flexibility to choose a primary major in either of the two colleges. See page 100 for details.

Honors Degree Programs in MCS

Several of the departments in MCS offer students an opportunity to participate in a departmental honors degree program. Some of these programs result in a master's degree along with the bachelor's degree (see next section on accelerated master's programs). These programs are listed below; see the department's section of the catalog for more details.

- Honors Program in Research Biology
- Departmental Honors in Chemistry
- Honors B.S./M.S. Program in Chemistry
- Honors B.S./M.S. Program in Mathematical Sciences

Accelerated Master's Programs

Carnegie Mellon offers some accelerated master's programs for motivated students, whereby students complete both the bachelor's and the master's degree in four or five years. Some programs are in the student's home department in MCS as part of an honors program, while others are offered through one of our graduate schools at Carnegie Mellon. Below is a listing of the programs currently available to MCS students; please see the appropriate sections of the catalog for more details.

- Honors B.S./M.S. Program in Chemistry
- Honors B.S./M.S. Program in Mathematical Sciences
- Accelerated Master's Program in the Heinz School of Public Policy and Management
- 3-1-1 Master's Program in Biotechnology Management (joint program between the Heinz School, Mellon College of Science, and the Tepper School of Business)

Pre-Professional Programs

Many students in the Mellon College of Science decide to pursue professional training such as medical school or law school after completing their undergraduate work. Carnegie Mellon offers strong advising services to support these students. Through these programs, students get help with everything from course selection to identification of important experiential opportunities to the application process itself.

Health Professions Program

Faculty Contact: Amy Burkert

Please see page 76 for details on the Health Professions Program.

Pre-Law Advising Program

Faculty Contact: Joseph Devine

Please see page 77 for details on the Pre-Law Advising Program.

University Self-Defined Majors

With a well-thought proposal, you may be able to pursue a major you have designed to meet your particular interests and goals. Please see the catalog section on Undergraduate Options on page 78 for more details about this opportunity.

Study Abroad

There are many programs for studying abroad, usually during your junior year. Please see the catalog section on Undergraduate Options on page 78 for more details, and talk with the Office of International Education to get information and advice specifically for you.

Applying Your Education Through Research

An important feature of education in MCS is the opportunity for undergraduate research experience. This experience may be arranged as a course taken for credit or occasionally as a part-time job. Our web site (www.cmu.edu/mcs/) offers a range of useful information including links to faculty research areas, links to undergraduate research programs at other institutions, and ideas on how to get involved. Because of the strong research base of MCS, undergraduate research positions offer an exciting opportunity to apply your theoretical training to participate in the discovery of new knowledge.

Students can earn MCS Research Honors for significant research accomplishments; see the policy outlined below for the requirements.

Mellon College of Science Research Honors

Undergraduates in the Mellon College of Science will be awarded MCS Research Honors at the completion of their degree if they have met one of these requirements:

1. Successfully completed the Honors BS/MS program in the Department of Chemistry or Department of Mathematical Sciences.
- Or
2. Successfully completed the departmental honors program in Biological Sciences or Chemistry.
- Or
3. Earned a cumulative grade point average of 3.20 or higher and carried out significant research. Typically, this would consist of an academic project carried out for at least two semesters.

However, a single project that spans a summer and a semester or that the research mentor deems to be significant and sustained, even if the student worked for pay rather than credit, will be allowed.

In addition, some form of public dissemination of this research such as a peer reviewed publication, research thesis, or presentation at an external scientific meeting is required. Please see www.cmu.edu/mcs/research/ug-res.html for details.

Final approval of nominations for MCS research honors will come from the Dean of MCS and the Associate Dean for Undergraduate Affairs.

Research Centers

The Mellon College of Science is home to a number of innovative research centers. These centers are particularly strong because of the interdisciplinary collaboration of their scientists. This interdisciplinary research brings international prestige to the college. Many students conduct undergraduate research with one of these centers.

The Art Conservation Research Center is dedicated to helping museums, libraries and archives improve the ways of caring for their collections. For over 50 years, the Center has been a world leader in discovering the origins of aging problems that threaten cultural property and in developing practical and effective strategies to inhibit or avoid deterioration.

The Bruce and Astrid McWilliams Center for Cosmology joins research efforts in astrophysics and particle physics and partners with computer science, statistics, and other disciplines to unravel the mysteries of the universe.

The Center of Atmospheric Particle Study's goal is to be the world leader in science, engineering, and policy covering the full role of fine particulate matter in the atmosphere. Our goal in research is to advance the state of knowledge across this spectrum substantially, to provide both policy-relevant research, and to participate directly and actively in the evolution of environmental policy related to particulate matter.

The Center for Computational Finance's mission is to improve the interaction between academic research and the finance industry.

The Center for Macromolecular Engineering's goals are to enhance the benefits of polymer science to society by developing new methods to prepare advanced polymer materials, train and develop tomorrow's scientists, and transfer technology to industry.

The Center of Nano-enabled Device and Energy Technologies' mission is to work on real-world problems that can be solved potentially with appropriate nano-enabled technologies.

The Center for the Neural Basis of Cognition is a joint program between Carnegie Mellon University and the University of Pittsburgh. It synthesizes the disciplines of basic and clinical neuroscience, cognitive psychology, and computer science, combining neurobiological, behavioral, computational, and brain imaging methods.

The Center for Nonlinear Analysis was established in 1991. A special focus for applications emphasizes new and innovative methods to study contemporary issues in materials science. The center has created a vigorous environment for collaboration among mathematical and allied scientists.

The Center for Nucleic Acids Science and Technology is a community of Carnegie Mellon scientists and engineers unified by interests in the chemistry, biology, and physics of DNA, RNA, and PNA (peptide nucleic acid).

The Institute for Green Oxidation Chemistry has been established as a research, education, and development center in which a holistic approach to sustainability science is being developed. The focus of the institute is in three areas: renewable energy technologies, chemical feedstocks, and benign alternatives to polluting technologies.

The Molecular Biosensor and Imaging Center uses an interdisciplinary approach to develop reagents, microscopes, and imaging tools and applies them to the investigation of fundamental problems in biology and biotechnology.

The Pittsburgh NMR Center for Biomedical Research is a joint program between Carnegie Mellon University and the University of Pittsburgh. It is supported as a Biotechnology Resource Center by the National Institutes of Health.

The Pittsburgh Supercomputing Center provides information on advanced scientific computing for engineering and research.

The Lane Center for Computational Biology seeks to realize the potential of machine learning for expanding our understanding of complex biological systems. A primary goal of the Center is to develop computational tools that will enable automated creation of detailed, predictive models of biological processes, including automated experiment design and data acquisition.

First Year for Science Students

An MCS education is based on a broad foundation in the sciences: two semesters each of calculus and physics and one semester each of biology, chemistry and computer science. This foundation corresponds to the following courses required for all MCS students.

Science Core Courses

21-120	Differential and Integral Calculus
21-122	Integration, Differential Equations, and Approximation
33-111	Physics for Science Students I
33-112	Physics for Science Students II
03-121	Modern Biology
09-105	Introduction to Modern Chemistry
15-100	Introductory/Intermediate Programming

In the first year, students take two semesters of calculus, 21-120 Differential and Integral Calculus and 21-122 Integration, Differential Equations, and Approximation. They also take three of the remaining five science core courses. The other two science core courses are completed by the end of the junior year. Additional courses in the first year include one course from the intended major; humanities, social sciences or fine arts courses; and Computing @ Carnegie Mellon, a course that introduces students to the computing environment and ethics of computing at Carnegie Mellon.

With this broad science background, a student is prepared to undertake any of the degree programs offered by the college when selecting a major at the end of the first year.

Fall Semester 41-47 units

21-120	Differential and Integral Calculus	10
xx-xxx	Science Core Course	9-12
xx-xxx	Science Core Course	10
76-101	Interpretation and Argument	9
99-101	Computing Skills Workshop	3
xx-xxx	Optional First-Year Seminar	3

Spring Semester 37-54 units

21-122	Integration, Differential Equations, and Approximation	10
xx-xxx	Science Core Course	9-12
xx-xxx	Departmental Elective from Intended Major	9-10
xx-xxx	Humanities, Social Sciences, or Fine Arts Course	9
xx-xxx	Optional Free Elective Course	9-10
xx-xxx	Optional First-Year Seminar	3

Notes

1. Departmental electives from the intended major are as follows:

Biological Sciences or Chemistry

09-106 Modern Chemistry II 10 units

Mathematical Sciences

21-127 Concepts of Mathematics 9 units

Physics

33-104 Experimental Physics 9 units

2. A free elective is any Carnegie Mellon course. However, a maximum of nine units of physical education, military science and/or STUCO courses may be taken as free electives in any MCS degree program. Credit earned for physical education, military science and STUCO courses will not be calculated in a student's QPA.

3. Students who enter with advanced placement credits will follow a similar schedule with modifications for their AP work.

MCS First-Year Laboratory Courses

In addition to the basic schedule that was outlined above, students have the option to take one of the following 3 or 6 unit elective inquiry-based laboratory courses:

03-115 Phage Genomics Research 6 units

The Department of Biological Sciences offers a two-semester research course in bacteriophage genomics. If you are interested in biological research, this course may be ideal for you. Genomics research combines experimental and computational approaches for large-scale analysis of the biological information contained in DNA sequences. The most abundant biological entities are bacteriophages. Their enormous diversity and number make bacteriophages important models for the study of gene structure, function and regulation, population genetics and evolution. This program is part of a national project sponsored by the Howard Hughes Medical Institute at selected institutions.

38-101 EUREKA! An Interdisciplinary Laboratory Experience 3 units

Come join the mini-Eureka team in solving a double-murder mystery employing state-of-the-art forensic methods. We will apply a little bit of chemistry, biology, physics, mathematics, and the history of science to determine "who done it." Using a fictitious narrative using the campus of CMU as a backdrop, we will apply the chemistry of gun shot residues, the physics of fingerprints and automobile skid marks, the biology of DNA "fingerprinting," and the formal logic of mathematics to analyze crime scene evidence.

Humanities, Social Sciences, and Fine Arts Requirements

All candidates for the bachelor's degree must complete a minimum of 72 units offered by the College of Humanities and Social Science and/ or the College of Fine Arts. These courses for MCS students are to meet the following distribution requirements:

A. Designated Writing Course (9 units)

76-101 Interpretation and Argument

B. Distributional Course Requirements (27 units)

Complete three courses, one each from Category 1, Category 2, and Category 3. Listed below are examples of courses that meet the requirement for each category. Students wishing to substitute a course that is not listed should meet with their advisor.

Category 1: Cognition, Choice and Behavior

80-130	Introduction to Ethics
80-150	Nature of Reason
80-180	Nature of Language
80-181	Language and Thought
80-208	Critical Thinking
80-212	Arguments and Logical Analysis
80-220	Philosophy of Science
80-221	Philosophy of Social Science
80-230	Ethical Theory
80-241	Ethical Judgments in Professional Life
80-242	Conflict, Dispute Resolution
80-270	Philosophy of Mind
80-271	Philosophy and Psychology
85-100	Introduction to Intelligence in Humans, Animals and Machines
85-102	Introduction to Psychology
85-211	Cognitive Psychology
85-221	Principles of Child Development
85-241	Social Psychology
85-251	Personality
85-261	Abnormal Psychology
88-120	Reason, Passion, and Cognition

Category 2: Economic, Political and Social Institutions

36-303	Sampling, Surveys, and Society
70-332	Business, Society, and Ethics
70-420	Entrepreneurship for Scientists
73-100	Principles of Economics
79-223	Protest and Dissent in American History
79-331	Crime and Punishment
79-335	Drug Use and Drug Policy
79-340	History of Modern Warfare
79-345	American Environmental History: Critical Issues
79-384	Medicine and Society
79-350	Theories of International Relations
80-135	Introduction to Political Philosophy
80-136	Social Structure, Public Policy, and Ethical Dilemmas
80-226	Revolutions in Science
80-235	Political Philosophy
80-236	Philosophy and the Law
80-243	Environment Management and Ethics
80-245	Medical Ethics
80-341	Computers, Society, and Ethics
88-104	Decision Processes in American Political Institutions
88-110	Experiments with Economic Principles
88-205	Comparative Politics
99-226	Rachel Carson: Her Work and Legacy
99-305	The Year is 1905: $E=mc^2$ Photons and Relativity

Category 3: Cultural Analysis

57-173	Survey of Western Music History
66-250	Introduction to Religion
70-342	Managing Across Cultures
76-227	Comedy
76-232	African-American Studies
76-241	Introduction to Gender Studies
79-104	Introduction to World History
79-113	Culture and Identity in American Society
79-201	Introduction to Anthropology
79-206	Development of American Culture
79-207	Development of European Culture
79-209	Theory and Practice in Anthropology
79-218	The Roots of Rock & Roll
79-241	African-American History I
79-242	African-American History II
79-255	Irish History
79-270	Chinese Culture and Society
79-368	Poverty, Charity, and Welfare
79-384	Medicine and Society
80-100	What Philosophy Is
80-151	God in the West
80-250	Ancient Philosophy
80-251	Modern Philosophy

80-253	Continental Philosophy
80-254	Analytical Philosophy
80-255	Pragmatism
80-261	Aesthetics of Mass Art
82-273	Introduction to Japanese Language & Culture
82-294	Topics in Russian Language and Culture
82-303	French Culture
82-304	Francophone World
82-325	Introduction to German Studies
82-333	Introduction to Chinese Language & Culture
82-342	Spain: Language and Culture
82-343	Latin America: Language and Culture
82-344	US Latinos: Language and Culture
82-345	Hispanic Literary and Cultural Studies

C. Elective Course Requirements (36 units)

Complete courses totaling 36 units from H&SS, CFA, or Business Administration. These can include language courses and music courses, for instance. In this category, you have the freedom to design how you want to structure your remaining general education requirements. For example you can use these electives to build a depth sequence of 2-4 courses in a particular area or you can take courses from different areas or some combination of each.

Check our web site for courses from H&SS, CFA and Business Administration that may not be used to satisfy these requirements, plus a list of courses in other colleges (including CIT and the Heinz School) that do satisfy these requirements. The direct URL is www.cmu.edu/mcs/education/edu.HSSFA.html.

Transfer into MCS Departments

Undergraduate students admitted to MCS can choose to pursue any major within MCS. This choice must be made prior to the first semester of the sophomore year (normally during the second semester of the first year) and does not require approval by any department.

Undergraduate students admitted to colleges other than MCS and wishing to transfer into an MCS department during their first year should consult with the MCS Associate Dean for Undergraduate Affairs. Undergraduate students will be considered for transfer after spring mid-semester grades for the first year have been posted.

MCS undergraduate students beyond the first year wishing to transfer into another MCS department may do so if they are not on academic probation and if there is room in the department of their choice. If the demand for any department exceeds the space available, then the department will admit students based on a comparative evaluation of all applicants at the end of each semester, up to the limit of available space.

Undergraduate students not in MCS and wishing to transfer into a department in MCS beyond the first year will be considered for transfer on a space available/academic performance basis. An MCS department may refuse a transfer to a non-MCS student if there are space restrictions and/or if the student's chance for success is determined to be questionable based on past academic performance.

Procedure for transfer of students from another university into an MCS department:

A student first applies through the Office of Admission. If the Office of Admission believes the applicant is acceptable, the student's record is sent to the appropriate department for evaluation and a decision on acceptance. The MCS department head has the right to refuse to accept the student if there are space restrictions and/or if the student's chance for success in the MCS department is determined to be questionable based on past academic performance.

Academic Standards and Actions

MCS Dean's List

Each semester MCS recognizes those students with outstanding academic records by naming them to the Dean's List. The criteria for such recognition are as follows:

Dean's List

The student must earn a quality point average of at least 3.5 while completing a minimum of 36 factorable units and earning no incomplete grades.

Dean's List High Honors

The student must earn a quality point average of at least 3.75 while completing a minimum of 36 factorable units and earning no incomplete grades.

Probation, Suspension, and Drop

In the first year, quality point averages below 1.75 in either semester invoke an academic action. For all subsequent semesters an academic action will be taken if the semester QPA or the cumulative QPA (excluding the first year) is below 2.00.

The relation indicated below between probation, suspension, and drop is normal, not binding. In unusual circumstances, MCS College Council may suspend or drop a student without prior probation.

Probation

The action of probation will be taken if:

- One semester of the first year is below 1.75 QPA.
- The semester QPA of a student in good standing beyond the first year falls below 2.00. The term of probation is one semester as a full-time student. First-year students are no longer on probation at the end of the second semester if their semester QPA is 1.75 or above.

A student is occasionally continued on probation who has had one semester on probation and is not yet meeting minimum requirements but whose record indicates that the standards are likely to be met at the end of the next semester of study.

Suspension

A student who does not meet minimum standards at the end of one semester of probation will be suspended.

A first-year student will be suspended if the QPA from each semester is below 1.75.

A student in the third or subsequent semester of study will be suspended if the semester factor or the cumulative factor (excluding the first year) is below 2.00 for two consecutive semesters.

The minimum period of suspension is one academic year (two semesters). At the end of that period a student may return to school on probation by:

- Receiving permission in writing from the Associate Dean of MCS.
 - Completing a "returning student's form" for Enrollment Services;
- and
- Providing transcripts and clearance forms if the student has been in a degree program at another college or university, even though academic credit earned will not transfer to Carnegie Mellon unless prior approval has been granted by the Associate Dean.

Employment within the university in non-student jobs is possible for students on academic suspension, subject to the hiring criteria of the hiring department. However, a student on academic suspension wishing to accept a job on campus must speak with the Associate Dean of the student's college to ensure that the employment will not constitute a violation of the terms of suspension. The Associate Dean will generally allow such employment, in consultation with the Dean of Student Affairs. One employment benefit not available to students on academic suspension who accept a full-time job with the University is the option to take courses through tuition remission. The option to take courses becomes available only after the academic suspension is over.

Drop

This is a permanent severance from the Mellon College of Science. Students are dropped when it seems clear that they will never be able to meet minimum standards. A student who has been suspended and who fails to meet minimum standards after returning to school is dropped.

A student who has been academically dropped or academically suspended and who is not employed by the University must absent themselves from campus and is, for the term of the suspension, barred from all activities and affiliations that stem from one's status as an enrolled student. These include registering or enrolling for courses, sitting in on classes, living in residence halls or Greek houses, membership and participation in student activities, and employment in student jobs. (NOTE: Exceptions to the restriction from student jobs for students on academic suspension will in general be granted for summer employment if the position was accepted prior to the decision to suspend.)

Graduation Requirements

A requirement for graduation is the completion of the program specified for a degree with a cumulative quality point average of 2.00 or higher for all courses taken after the first year. A minimum of 360 units must be completed. This will include the MCS Science Core Courses, H&SS or CFA requirements and all departmental course requirements.

Students will be required to meet the residency requirement and to have met all financial obligations to the university before being awarded a degree. (The residency requirement is detailed on p. 58)

A student may seek permission to modify graduation requirements by petition to the MCS College Council.

Graduation Honors

There are two types of honors awarded at graduation.

University Honors

University Honors are automatically awarded to students who have earned a cumulative Q.P.A. of 3.5 or better after seven semesters.

College Research Honors

Please see the section "Applying your Education through Research" on page 297 for information on how to qualify for College Research Honors.

Minors Offered by the Mellon College of Science

The Mellon College of Science offers several minors to students interested in broadening their scientific training or acquiring a level of expertise in a particular scientific field. The intercollege minors described below are designed to supplement your degree in science; the departmental minors offer you a means of exploring another field and are open to students throughout the university.

Intercollege Minors

Please see the descriptions below.

- Environmental Science
- Health Care Policy and Management
- Scientific Computing

Departmental Minors in the Mellon College of Science

For descriptions, please see the departmental sections which follow.

- Biological Sciences
- Chemistry
- Computational Finance
- Discrete Mathematics and Logic
- Mathematical Sciences
- Physics

The Minor in Health Care Policy and Management

Sponsored by:

H. John Heinz III School of Public Policy and Management
College of Humanities and Social Sciences
Mellon College of Science

Faculty Advisors:

Caroline Acker, College of Humanities and Social Sciences
Brenda Peyser, H. John Heinz III School of Public Policy and Management, Amy Burkert, Mellon College of Science

The face of health care is changing. The practice of medicine is being fundamentally altered by the forces of change in public policy, health care organizations and in the industry as a whole. The role of individual professionals in this industry is changing as rapidly as the industry itself. Traditional career paths have disappeared overnight to be replaced by new opportunities that require new skills. New organizations are placing new demands on their professional and medical staffs. The criteria of efficiency and financial stability are entering the domains of diagnosis and treatment.

This minor is designed to provide students considering a career in the health professions with an understanding of how these changes are likely to affect their careers. Students will become familiar with the critical policy and management issues and will begin to learn to operate effectively in the emerging health care environment. The curriculum combines economic, organizational, managerial, historical and psychological perspectives on these issues to provide a foundation for a deepened understanding of the changing structure of health care organizations and policy.

Curriculum (minimum) 60 units

Seven courses (a minimum of 60 units) are required to complete this minor. Entry into the minor requires completion of 73-100, Economics or 88-220, Policy Analysis I or the equivalent by approval.

Required Courses 33 units

Students are required to take the following courses.

79-384	Medicine and Society (9 units)
90-735	Health Economics (12 units)
90-836	Health Systems (6 units)
90-861	Health Policy I (6 units)

Elective Courses 27 units

Complete a minimum of 27 units.

Heinz School Courses

91-830	Financial Management of Health Systems
91-836	Legal Issues in Health Systems Management
91-844	Managing Quality Improvement
91-853	Health Care Information Systems
91-xxx	Health Policy II
91-862	Managed Care

Humanities and Social Sciences Courses (9 units each)

76-494	Healthcare Communications
79-335	Drug Use and Drug Policy
79-336	Epidemic Disease and Public Health
80-245	Medical Ethics
80-247	Health, Development, and Human Rights
85-241	Social Psychology
85-442	Health Psychology
85-446	The Psychology of Gender

Please note that some of these courses have prerequisites that will not count toward the completion of the requirements for this minor.

Minor in Environmental Science

Faculty Contact:

Neil Donahue, Chemistry and Chemical Engineering Departments

The primary mission of the environmental sciences minor is to prepare students in the Mellon College of Science for careers or postgraduate education in the diverse fields of environmental science. We feel strongly that these endeavors must be grounded in strong fundamental science; consequently, the program extends majors in the Mellon College of Science. We also award minors to students from other colleges, provided that they can build a course of study with sufficient scientific rigor to meet the standards of the program.

As a capstone program, the minor is built around advanced courses that extend as well as broaden the specialized education associated with the major programs. Environmental sciences are highly interdisciplinary in nature, and while it is necessary that students have an exposure to introductory courses in several of these disciplines, it is by no means sufficient; in-depth knowledge is required. We encourage all students to pursue generally broad studies, including subjects that encompass human interactions with the environment, and will provide guidance to all students interested in the area. We encourage those students who intend to devote focused attention to environmental sciences to pursue this minor.

Environmental Sciences are broadly defined as pursuits designed to develop fundamental understanding of the natural environment and human interactions with the environment. Research problems are frequently motivated by perceived problems (air, water and soil pollution, reduction in biodiversity, global climate change, etc...), but inevitably extend to the fundamental mechanisms underlying these phenomena. Research can be highly specialized (focusing for example on the biochemistry of a particular enzyme or the synthesis of a particular catalyst) or highly general (focusing for example on the complex, nonlinear interactions of populations on complex ecosystems). Our program is designed to ensure that students of the field are conversant with questions on all of these scales, from the microscopic to the global.

Required Courses:**Science Requirements (27 units)**

09-217	Organic Chemistry I
09-218	Organic Chemistry II
03-231/ 232	Biochemistry I

Laboratory Requirement (12 units)

09-221	Laboratory 1: Introduction to Chemical Analysis
12-252	Environmental Engineering Lab

Statistics Requirement (9 units)

36-247	Statistics for Laboratory Sciences
12-251	Introduction to Environmental Engineering

Additional Course Requirements:

Complete one course from each of the following groups (substitutions can be made with the approval of the Environmental Science Advisor).

Note: Courses taken in these categories cannot also be counted toward requirements for a primary major.

Science (Mechanism)

03-442	Molecular Biology of Eukaryotes
09-510	Introduction to Green Chemistry
09-520	Special Topics in Atmospheric Chemistry
06-630	Atmospheric Chemistry: Air Pollution & Global Change
12-726	Mathematical Modeling of Environmental Quality Systems

Engineering (Process)

12-651	Air Quality Engineering
12-655	Water Quality Engineering
12-720	Water Resource Chemistry
42-606	Biotechnology & Environmental Processes

Policy

19-446	Quantitative Research Analysis
19-448	Science, Technology, & Ethics
73-358	Economics of the Environmental & Natural Resources
79-365	Climate Change, Environmental Policy & Practice
80-244	Management, the Environment, & Ethics
80-352	International Environmental Law & Policy

Minor in Scientific Computing

Faculty Contact:
Richard Holman, Physics Department

Sometimes called "computational science," scientific computing is the application of high-performance computers and modern computational technologies to problems in the sciences and engineering. Research in this area is inherently multidisciplinary, requiring strong ties with a scientific discipline.

MCS students can easily build on their scientific training with this applied computational program. The curriculum consists of five areas of concentration, which span the natural sciences, mathematics, programming and research. The curriculum is structured to allow flexibility in choosing courses that meet students' particular interests or best complement their major. The minor is also a natural choice for students majoring in any technical area.

Required Courses

Students must meet the requirements of the following categories:

A. Non-Introductory Science Requirement (9-12 units)

Complete 1 course from Biological Sciences, Chemistry, or Physics at the 200 level or higher, excluding those courses listed below as part of the requirements of the minor. Courses with a significant science component from other colleges may be substituted with approval from the program administrator.

B. Computational Science Requirement (18-24 units)

Complete 2 of the following courses:

03-310	Introduction to Computational Biology
or	
03-510	Computational Biology
09-560	Computational Chemistry
33-241	Introduction to Computational Physics

C. Computational Methods Requirement (9 units)

Complete one of the following courses from outside of your home department.

21-320	Symbolic Programming Methods
21-369	Numerical Methods
21-380	Introduction to Mathematical Modeling
33-232	Physical Analysis
33-456	Advanced Computational Physics
36-410	Introduction to Probability Modeling

D. Applied Scientific Computing Research Project(s) (9 units)

Complete one approved research project in an area of applied scientific computing. In some cases, this research could be replaced with 9 units of an approved project-based course in advanced scientific computing. The administrator of the minor will maintain a list of appropriate courses. Under special circumstances summer research may count toward this requirement, although it cannot be counted toward the units required for graduation.

E. Complete any additional course from category C or D (9 units)

Department of Biological Sciences

John L. Woolford, Acting Head
Undergraduate Office: Doherty Hall 1320
<http://www.cmu.edu/bio>

A major revolution is occurring in the field of biological sciences. Biology is undergoing unprecedented technological advances in biochemistry, biophysics, cell biology, genetics, molecular biology, developmental biology, neuroscience and computational biology. Carnegie Mellon's Department of Biological Sciences is nationally recognized as one of the outstanding departments in these areas. Advances in basic research are already being used to solve problems, not only in medicine and public health, but also in areas such as agriculture, forestry, mining, energy, and in industrial and pharmaceutical manufacturing processes. The department provides its students with an education that has both intellectual breadth and depth of exposure to modern research biology. This education can be used to gain employment immediately after graduation in government, industry or academic research laboratories, or to pursue graduate studies in a variety of areas such as science, medicine, public health, law or business. A degree in biological sciences provides excellent preparation for medical school or other graduate programs in the health professions. These students are aided by the Carnegie Mellon Health Professions Program (HPP), an advisory and resource service for all Carnegie Mellon students who are considering careers in the health care field. (See www.cmu.edu/hpp for more information.)

The department offers a bachelor of science (B.S.) degree in biological sciences. This program has a distinctive core curriculum that provides a foundation in biology, chemistry, computer science, mathematics and physics. In addition to the core courses, the program includes six biology electives, five free electives and eight humanities, social science and fine arts electives. With these electives, students can shape a degree program according to their own interests and career goals. For students who have an interest in a particular field of biology and wish to have a specialized focus, the department offers options in biochemistry, biophysics, cell biology, computational biology, developmental biology, genetics, molecular biology and neuroscience that provide the relevant training in each area. The options are especially recommended for students who are considering graduate school in one of these areas. For those students who are interested in an in-depth study of neuroscience, a new degree (B.S. in Biological Sciences/Neuroscience Track) has been developed.

In this exciting era that includes the influence of biology and the life sciences on many fields from medicine to law, the in-depth exposure to multiple disciplines provides opportunities for students to prepare for involvement at the forefront of emerging new fields, markets and policy changes. The Department of Biological Sciences at Carnegie Mellon is working at these new interfaces through interdisciplinary research and educational programs. Innovative interdisciplinary degrees which are offered by the department include the intercollege BS degree in Computational Biology as well as an unified BS degree in Biological Sciences and Psychology. A bachelor of arts (B.A.) degree is available when coupled with an additional major from a non-technical discipline. Many students chose to broaden their education by pursuing minors and additional majors in disciplines throughout the university, not just within the Mellon College of Science. Students also explore interdisciplinary studies through the Science and Humanities Scholars program, or pursue interests at the interface between the arts and sciences through the Bachelor of Science and Arts (B.S.A.) degree program combining biological sciences with a discipline in the College of Fine Arts.

One of the most important features of the Department of Biological Sciences is the opportunity for undergraduate students to interact with faculty. The faculty members are prominent research scientists who also teach beginning and advanced courses. The teaching laboratories are located in the same building as the faculty research laboratories and share scientific equipment. We encourage students to be aware of the faculty research work and to develop research projects with faculty. While such research is usually most important in the senior year, it may begin earlier in a student's undergraduate training. The department has an Honors Program in Research Biology that is intended to facilitate a more intensive involvement in research for eligible students. During the past four years, more than 80 percent of the undergraduate biology majors have worked with faculty on their research and, in some cases, have been co-authors of research papers and have given presentations at national meetings.

B.S. Biological Sciences

The B.S. in Biological Sciences is built around a core program and elective units as detailed in the following section.

Course Requirements	Units
Biological Sciences	
03-121 Modern Biology	9
03-231/232 Biochemistry	9
03-240 Cell Biology	9
03-330 Genetics	9
03-343 Experimental Genetics and Molecular Biology	12
03-344 Experimental Biochemistry or	12
03-345 Experimental Cell and Developmental Biology	
03-201 Colloquium	1
03-202 Colloquium	1
03-411 Topics in Research	1
03-412 Topics in Research	1
03-XXX Biological Sciences Electives*	54
Mathematics, Physics and Computer Science	
21-120 Differential and Integral Calculus	10
21-122 Integration, Differential Equations, and Approximation	10
33-111 Physics for Science Students I	12
33-112 Physics for Science Students II	12
15-100 Introductory/Intermediate Programming	10
99-101/102/103 Computing @ Carnegie Mellon	3
Chemistry	
09-105 Introduction to Modern Chemistry	10
09-106 Modern Chemistry II	10
09-217 Organic Chemistry I	9
09-218 Organic Chemistry II	9
09-221 Laboratory I: Introduction to Chemical Analysis	12
09-222 Laboratory II: Organic Synthesis and Analysis	12
09-214 Physical Chemistry	9
Total	246
Elective Units	
Free Electives	42
H&SS and Fine Arts Electives	72
Minimum number of units required for degree:	360

* Biological Sciences Electives

The following specifications apply to Biological Sciences electives:

- At least 18 units must be at the 03-3xx level or above, exclusive of 03-445 Undergraduate Research.
- Up to three interdisciplinary electives may count as biology electives.
- Up to 18 units of 03-445 Undergraduate Research may count as general biology electives; a maximum of 36 units can count for the minimum units required for graduation.
- Courses in biology taken through cross-registration or study abroad at another university may count as electives if prior permission is obtained from the Carnegie Mellon Department of Biological Sciences advisor.

Departmental Electives Group

03-115/116 Phage Genomics Research	
03-122 Organismic Botany	
03-124 Modern Biology Laboratory	
03-125 Evolution and the History of Life	
03-203 Bench to Bedside: Process of Regenerative Therapeutics	
03-204 Information, Entropy and Noise in the Brain	
03-230 Introduction to Mammalian Physiology	
03-310 Introduction to Computational Biology	
03-311 Introduction to Computational Molecular Biology	
03-315 Magnetic Resonance Imaging in Neuroscience	

03-325	Evolution
03-350	Developmental Biology
03-362	Cellular Neuroscience
03-363	Systems Neuroscience
03-380	Virology
03-390	Molecular and Cellular Immunology
03-391	Microbiology
03-392	Microbiology Laboratory
03-439	Introduction to Biophysics
03-442	Molecular Biology
03-445	Undergraduate Research
03-450	Cellular and Genetic Mechanisms of Development
03-510	Computational Biology
03-511	Computational Molecular Biology and Genomics
03-512	Computational Methods for Biological Modeling and Simulation
03-513	Bioinformatics Data Integration Practicum
03-534	Biological Imaging and Fluorescence Spectroscopy
03-545	Honors Research
03-620	Techniques in Electron Microscopy
03-710	Computational Biology
03-711	Computational Genomics and Molecular Biology
03-712	Computational Methods for Biological Modeling and Simulation
03-713	Bioinformatics Data Integration Practicum
03-715	Graduate Computational Genomics
03-725	Advanced Evolution
03-730	Advanced Genetics
03-740	Advanced Biochemistry
03-741	Advanced Cell Biology
03-742	Advanced Molecular Biology
03-744	Membrane Trafficking
03-751	Advanced Developmental Biology
03-761	Neural Plasticity in Sensory and Motor Systems
03-762	Advanced Cellular Neuroscience
03-763	Advanced Systems Neuroscience
03-815	Advanced Magnetic Resonance Imaging in Neuroscience
03-871	Structural Biophysics

Interdisciplinary Electives Group

Up to three of the following courses may count as biology electives

09-518	Bioorganic Chemistry: Nucleic Acids and Carbohydrates
09-519	Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry
09-521	Bioinorganic Chemistry
15-211	Fundamental Structures of Computer Science I
21-127	Concepts of Mathematics
21-259	Calculus in Three Dimensions
21-260	Differential Equations
36-201	Statistical Reasoning and Practice
36-247	Statistics for Lab Sciences
42-202	Physiology
42-621	Biotechnology and Environmental Processes
85-219	Biological Foundations of Behavior

Options for the B.S. in Biological Sciences

Students who wish to specialize in a particular area of biology can do so through a set of departmentally defined options. Students who complete the required biology electives for any option can have up to two noted on his or her transcript. Options need not be declared. The elective courses required for each of the options are listed below.

Biochemistry Option

Required Biology Electives:
03-740 Advanced Biochemistry
21-259 Calculus in Three Dimensions
or
21-260 Differential Equations

Any one of the following courses:

09-518	Bioorganic Chemistry: Nucleic Acids and Carbohydrates
09-519	Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry
09-521	Bioinorganic Chemistry

Recommended Biology Electives:

03-442	Molecular Biology
03-534	Biological Imaging and Fluorescence Spectroscopy
03-439	Introduction to Biophysics
03-871	Structural Biophysics

Biophysics Option

Required Biology Electives:

03-740	Advanced Biochemistry
03-439	Introduction to Biophysics
21-259	Calculus in Three Dimensions
or	
21-260	Differential Equations

Recommended Biology Electives:

03-315	Magnetic Resonance Imaging in Neuroscience
03-534	Biological Imaging and Fluorescence Spectroscopy
03-871	Structural Biophysics

Cell Biology Option

Required Biology Electives:

03-350	Developmental Biology
03-741	Advanced Cell Biology

One of the following courses:

03-362	Cellular Neuroscience
03-390	Molecular and Cellular Immunology

Computational Biology Option

Required Biology Electives:

03-710	Computational Biology
15-211	Fundamental Structures and Algorithms I

Any one of the following courses:

36-247	Statistics for Laboratory Sciences
21-260	Differential Equations
21-241	Matrix Algebra

Recommended Biology Electives:

03-511	Computational Molecular Biology and Genomics
03-512	Computational Methods for Biological Modeling
15-212	Fundamental Structures of Computer Science II
15-451	Algorithm Design and Analysis
09-560	Computational Chemistry

Developmental Biology Option

Required Biology Electives:

03-350	Developmental Biology
03-442	Molecular Biology
03-751	Advanced Developmental Biology

Recommended Biology Electives:

03-325	Evolution
03-741	Advanced Cell Biology

Genetics Option

Required Biology Electives:

03-325	Evolution
03-442	Molecular Biology
03-730	Advanced Genetics (minimum grade of B in 03-330 required)

Recommended Biology Electives:

03-311	Introduction to Computational Biology
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Molecular Biology Option

Required Biology Electives:

03-442	Molecular Biology
Or 03-742	with permission of instructor
09-518	Bioorganic Chemistry: Nucleic Acids and Carbohydrates

Any one of the following:

03-325	Evolution
03-380	Virology
03-390	Molecular and Cellular Immunology
03-730	Advanced Genetics

Neuroscience Option

Required Biology Electives:

03-362	Cellular Neuroscience
03-363	Systems Neuroscience

Any two of the following courses:

03-230	Introduction to Mammalian Physiology
03-315	Magnetic Resonance Imaging in Neuroscience
03-350	Developmental Biology
03-534	Biological Imaging and Fluorescence Spectroscopy
03-761	Neural Plasticity in Sensory and Motor Systems
85-219	Biological Foundations of Behavior

B.S. in Biological Sciences/ Neuroscience Track

The BS in Biological Sciences/Neuroscience Track provides an option for those Biological Sciences majors who are interested in an intensive curricular focus in neuroscience. The requirements of the Track are the same as those listed for the BS in Biological Sciences with the following changes to the biological sciences elective requirements:

Required Courses:

03-362	Cellular Neuroscience
03-363	Systems Neuroscience
03-761	Neural Plasticity in Sensory and Motor Systems

Plus three of the following electives:

03-230	Introduction to Mammalian Physiology
03-315	Magnetic Resonance Imaging in Neuroscience
03-350	Developmental Biology
03-534	Biological Imaging and Fluorescence Spectroscopy
15-485	Computational Perception and Scene Analysis
15-385	Computer Vision
15-490	Computational Neuroscience
85-211	Cognitive Psychology
85-213	Human Information Processing and Artificial Intelligence
85-219	Biological Foundations of Behavior

Mini courses of possible interest:

03-101	Nature & Nurture in Brain Development
03-101	From Photons to Psychophysics
03-204	Information, Entropy and Noise in the Brain

B.S. Computational Biology

The B.S. in Computational Biology is now listed in the Intercollege section of this catalog. It is a joint degree program offered with the School of Computer Science.

Professional Masters Degree in Computational Biology

Students who are interested in more advanced training in this emerging field may want to consider the Professional Master of Science Program in Computational Biology. For more information on this program, contact the Department of Biological Sciences.

B.S. Biological Sciences and Psychology

This unified major is intended to reflect the interdisciplinary nature of current research in the fields of biology and psychology, as well as the national trend in some professions to seek individuals broadly trained in both the social and natural sciences. Students in the Mellon College of Science will earn a B.S. in Biological Sciences and Psychology. Students in the joint SHS program can complete the SHS educational core and choose either departmental order for their diploma.

Course Requirements	Units
Biological Sciences	
03-121 Modern Biology	9
03-231/232 Biochemistry	9
03-240 Cell Biology	9
03-330 Genetics	9
03-343 Experimental Genetics and Molecular Biology	12
03-201 Colloquium	1
03-202 Colloquium	1
03-411 Topics in Research	1
03-412 Topics in Research	1
03-XXX General Biology Elective	9
03-3XX Advanced Biology Elective	9
03-3XX Advanced Biology Elective	9

Mathematics, Statistics, Physics and Computer Science

21-120	Differential and Integral Calculus	10
21-122	Integration, Differential Equations, and Approximation	10
36-247	Statistics for Lab Sciences	9
36-309	Experimental Design for Behavioral and Social Sciences	9
33-111	Physics for Science Students I	12
33-112	Physics for Science Students II	12
15-100	Introductory/Intermediate Programming	10

99-101/102/103	Computing @ Carnegie Mellon	3
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Chemistry

09-105	Introduction to Modern Chemistry	10
09-106	Modern Chemistry II	10
09-217	Organic Chemistry I	9
09-218	Organic Chemistry II	9
09-221	Laboratory I: Introduction to Chemical Analysis	12
09-222	Laboratory II: Organic Synthesis and Analysis	12

Psychology Courses

85-102	Introductory to Psychology	9
85-219	Biological Foundations of Behavior	9
85-2XX *	Survey Psychology Courses	18
85-310 or 85-320 or 85-340	Research Methods in Psychology	9
85-3XX	Advanced Psychology Electives	18

Advanced Biological Sciences or Psychology Elective

85-3XX or 03-3XX	Advanced Psychology Elective or Advanced Biology Elective	9
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Additional Laboratory or Research Methods

(Choose one of the following courses)		9-12
03-344	Experimental Biochemistry	
03-345	Experimental Cell and Developmental Biology	
85-310	Research Methods in Cognitive Psychology	
85-320	Research Methods in Developmental Psychology	
85-340	Research Methods in Social Psychology	

Elective Units

Free Electives	33-36
H&SS and Fine Arts Electives	27

Minimum number of units required for degree: 360

* Excluding 85-261, Abnormal Psychology

B.A. Biological Sciences with an Additional Major

The Department of Biological Sciences offers a B.A. when combined with an additional major that is intended for students who wish to combine their interest in science with one of the majors in the College of Humanities and Social Sciences. The requirements for the B.A. degree are distributed as follows:

Course Requirements	Units	
Biological Sciences		
03-121 Modern Biology	9	
03-231/232 Biochemistry	9	
03-240 Cell Biology	9	
03-330 Genetics	9	
03-124 Modern Biology Laboratory or		
03-343 Experimental Genetics and Molecular Biology	9-12	
03-201 Colloquium	1	
03-202 Colloquium	1	
03-411 Topics in Research	1	
03-412 Topics in Research	1	
03-XXX General Biology Electives	18	
03-3XX Advanced Biology Elective	9	
Mathematics, Physics and Computer Science		
21-120 Differential and Integral Calculus	10	
21-122 Integration, Differential Equations, and Approximation	10	
33-111 Physics for Science Students I	12	
33-112 Physics for Science Students II	12	
15-100 Introductory/Intermediate Programming	10	
99-101/102/103	Computing @ Carnegie Mellon	3
Chemistry		
09-105	Introduction to Modern Chemistry	10
09-106	Modern Chemistry II	10
09-217	Organic Chemistry I	9
09-218	Organic Chemistry II	9
09-221	Laboratory I: Introduction to Chemical Analysis	12
09-222	Laboratory II: Organic Synthesis and Analysis	12

Elective Units

MCS required distribution courses in H&SS and Fine Arts 36
 Courses as specified for the additional major and
 Free Electives 126-129

Minimum number of units required for degree: 360

Honors Program in Research Biology

The departmental Honors Program offers an opportunity to become extensively involved in research. The program requires students to conduct an independent project and to prepare a formal thesis that is written and defended in the senior year. This program does not preclude a student from completing any of the options within the department nor is it the only way in which students can participate in undergraduate research although it is excellent preparation for graduate studies.

Minor in Biological Sciences

All university students are eligible to pursue a minor in biological sciences in conjunction with a major in any other department in the university. A minimum of six biological sciences courses and two chemistry prerequisites must be completed to fulfill the minor in biological sciences. The curriculum includes four required courses and two elective courses as specified below. Units awarded for undergraduate research are not applicable to elective courses. Courses taken in other departments or colleges will be considered on an individual basis.

Courses for the Minor	Units
Prerequisites:	
09-105 Introduction to Modern Chemistry	10
09-217 Organic Chemistry I	9
Required courses:	
03-121 Modern Biology	9
03-231/232 Biochemistry	9
03-240 Cell Biology	9
03-330 Genetics	9
03-XXX General Biology Elective	9
03-3XX Advanced Biology Elective	9
Total	73

Faculty

ERIC T. AHRENS, Associate Professor of Biological Sciences — Ph.D., University of California, Los Angeles; Carnegie Mellon, 2000—.

ALISON L. BARTH, Associate Professor of Biological Sciences - Ph.D., University of California, Berkeley; Carnegie Mellon, 2002—.

PETER B. BERGET, Associate Professor of Biological Sciences — Ph.D., University of Minnesota; Carnegie Mellon, 1986—.

CHRISTOPHER W. BORYSENKO, Director, MCS Interdisciplinary Laboratory and Lecturer, Department of Biological Sciences; Ph.D., Brandeis University; Carnegie Mellon 2004—

AMY L. BURKERT, Teaching Professor of Biological Sciences; Assistant Dean for the Health Professions Program and Educational Initiatives, Mellon College of Science— Ph.D., Carnegie Mellon University; Carnegie Mellon, 1997—.

JUSTIN C. CROWLEY, Assistant Professor of Biological Sciences, — Ph.D., Duke University; Carnegie Mellon, 2003—.

CARRIE B. DOONAN, Teaching Professor of Biological Sciences — Ph.D., University of Connecticut; Carnegie Mellon, 1993—.

M. DANNIE DURAND, Associate Professor of Biological Sciences — Ph.D., Columbia University; Carnegie Mellon, 2000—.

CHARLES A. ETTENSOHN, Professor of Biological Sciences — Ph.D., Yale University; Carnegie Mellon, 1987—.

ERIC W. GROTZINGER, Teaching Professor of Biological Sciences; Associate Dean, Mellon College of Science — Ph.D., University of Pittsburgh; Carnegie Mellon, 1979—.

DAVID D. HACKNEY, Professor of Biological Sciences — Ph.D., University of California, Berkeley; Carnegie Mellon, 1978—.

VERONICA F. HINMAN, Assistant Professor of Biological Sciences — Ph.D., University of Queensland; Carnegie Mellon, 2006—.

CHIEN HO, Alumni Professor of Biological Sciences; Director, NMR Center for Biomedical Research — Ph.D., Yale University; Carnegie Mellon, 1979—.

JEFFREY O. HOLLINGER, Professor of Biological Sciences and Biomedical Engineering; Director, Bone Tissue Engineering Center — Ph.D., D.D.S., University of Maryland; Carnegie Mellon, 2000—.

JONATHAN W. JARVIK, Associate Professor of Biological Sciences — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1978—.

LINDA R. KAUFFMAN, Teaching Professor of Biological Sciences — Ph.D., University of Pittsburgh; Carnegie Mellon, 1977—.

FREDERICK LANNI, Associate Professor of Biological Sciences — Ph.D., Harvard University; Carnegie Mellon, 1982—.

CHRISTINA H. LEE, Assistant Professor of Biological Sciences — Ph.D., University of California, San Francisco; Carnegie Mellon, 2000—.

ADAM D. LINSTEDT, Professor of Biological Sciences — Ph.D., University of California, San Francisco; Carnegie Mellon, 1995—.

ANTONIO-JAVIER LÓPEZ, Associate Professor of Biological Sciences — Ph.D., Duke University; Carnegie Mellon, 1989—.

MARK MACBETH, Assistant Professor of Biological Sciences— Ph.D., University of Chicago; Carnegie Mellon, 2007—.

BROOKE M. MCCARTNEY, Assistant Professor of Biological Sciences— Ph.D., Duke University; Carnegie Mellon, 2003—.

JONATHAN S. MINDEN, Professor of Biological Sciences — Ph.D., Albert Einstein College of Medicine; Carnegie Mellon, 1990—.

AARON P. MITCHELL, Professor of Biological Sciences— Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2008—.

ROBERT F. MURPHY, Professor of Biological Sciences, Biomedical Engineering and Machine Learning — Ph.D., California Institute of Technology; Carnegie Mellon, 1983—.

JOHN F. NAGLE, Professor of Physics and Biological Sciences — Ph.D., Yale University; Carnegie Mellon, 1967—.

GORDON S. RULE, Robert Eberly Professor of Biological Sciences — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1996—.

RUSSELL S. SCHWARTZ, Associate Professor of Biological Sciences — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2002—.

V. EMILY STARK, Associate Teaching Professor, Biological Sciences, Coordinator of Graduate Programs — M.S., Carnegie Mellon University; Carnegie Mellon, 2003—.

NATHAN N. URBAN, Associate Professor of Biological Sciences — Ph.D., University of Pittsburgh; Carnegie Mellon, 2002—.

ALAN S. WAGGONER, Professor of Biological Sciences; Director, Molecular Biosensor and Imaging Center — Ph.D., University of Oregon; Carnegie Mellon, 1999—.

JAMES F. WILLIAMS, Professor of Biological Sciences — Ph.D., University of Toronto; Carnegie Mellon, 1976—.

JOHN L. WOOLFORD JR., Professor of Biological Sciences — Ph.D., Duke University; Carnegie Mellon, 1979—.

Adjunct Faculty

CYNTHIA M. MORTON, Associate Curator of the Carnegie Museum of Natural History— Ph.D., New York Botanical Garden/CUNY; Carnegie Mellon, 2002—.

PETER L. STRICK, Professor, Co-Director of the Center for the Neural Basis of Cognition, Neurobiology, and Psychiatry, University of Pittsburgh — Ph.D., University of Pennsylvania; Carnegie Mellon, 2000—.

D. LANSING TAYLOR, President and Chief Executive Officer of Cellumen, Inc. — Ph.D., State University of New York at Albany; Carnegie Mellon, 1982—.

GEORGE S. ZUBENKO, Professor of Psychiatry, University of Pittsburgh School of Medicine — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1984—.

Affiliated Faculty

BRUCE A. ARMITAGE, Associate Professor of Chemistry — Ph.D., University of Arizona; Carnegie Mellon, 1997-.

ZIV BAR-JOSEPH, Assistant Professor, Center for Automated Learning and Discovery, School of Computer Science — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2003—.

PHIL G. CAMPBELL, Associate Research Professor, Institute for Complex Engineered Systems, Carnegie Institute of Technology— Ph.D. Pennsylvania State University; Carnegie Mellon, 1999—.

WILLIAM F. EDDY, Professor of Statistics— Ph.D., Yale University; Carnegie Mellon, 1976—.

T.D. JACOBSEN, Assistant Director and Principal Research Scientist, Hunt Institute for Botanical Documentation — Ph.D., Washington State University; Carnegie Mellon, 1979—.

ROBERT W. KIGER, Distinguished Service Professor of Botany; Professor of History of Science; Director and Principle Research Scientist, Hunt Institute for Botanical Documentation — Ph.D., University of Maryland; Carnegie Mellon, 1974—.

CHRISTOPHER J. LANGMEAD, Assistant Professor of Computer Science — Ph.D., Dartmouth College; Carnegie Mellon 2004—.

PHILIP R. LEDUC, Assistant Professor of Mechanical Engineering — Ph.D., The Johns Hopkins University; Carnegie Mellon, 2002—.

CARL OLSON, Professor of the Center for the Neural Basis of Cognition — Ph.D., University of California, Berkeley; Carnegie Mellon, 1996—.

JOEL R. STILES, Associate Professor of Mellon College of Science and Senior Scientific Specialist, Pittsburgh Super Computing Center— Ph.D., M.D., University of Kansas School of Medicine; Carnegie Mellon, 1999—.

FREDERICK UTECH, Principal Research Scientist, Hunt Institute for Botanical Documentation — Ph.D., Washington University; Carnegie Mellon, 1977—.

ERIC P. XING, Assistant Professor of Computer Science — Ph.D., University of California, Berkeley; Carnegie Mellon, 2004—.

Emeritus Faculty

WILLIAM R. MCCLURE, Professor of Biological Sciences — Ph.D., University of Wisconsin; Carnegie Mellon, 1981—.

C. ROY WORTHINGTON, Professor of Biological Sciences — Ph.D., Adelaide University; Carnegie Mellon 1969—

Department of Chemistry

Hyung J. Kim, Head
 Karen H. Stump, Director of Undergraduate Studies
 Office: Doherty Hall 1317
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Carnegie Mellon provides a family-like but very vibrant and interdisciplinary environment for science students. One of our major strengths is that most of our undergraduate students in chemistry and related fields get involved in research in faculty labs early on and get hands-on experience in cutting-edge research, some even as freshmen. Our curriculum is both fluid and innovative to give students broad background and in-depth knowledge in chemistry and interdisciplinary areas. —Dr. Hyung J. Kim

Chemistry is an area of science involved with the study of the properties and reactions of substances ranging from living cells to subatomic particles. It is at the center of many sciences, providing the fundamental knowledge and tools needed to address many of society's needs and to explore the unknown. Fields as diverse as genetic engineering and nanotechnology look to chemistry when they look to the future, for that is where the ultimate in understanding — the molecular level — resides.

The chemistry profession is extraordinarily diverse, with career opportunities available in the chemical, petroleum, plastics, metals, and pharmaceutical industries. Chemistry plays an increasingly important role in the rapidly expanding biomedical and biotechnology industries. In addition to careers in industry and academia, many chemists find challenging careers in the public sector in the laboratories of the National Institutes of Health, the Department of Agriculture, the Environmental Protection Agency, the National Institute of Standards and Technology, and the Department of Energy as well as in consulting.

Chemistry is a particularly suitable major for pre-medical and other pre-health profession students. Medical schools look favorably on the rigorous reasoning skills chemists develop, as evidenced by an excellent record for student admission to advanced education in these areas. An increasing number of our graduates are seeking careers in dentistry, pharmacy or pharmacology. The Health Professions Program advises all Carnegie Mellon students considering careers in health fields. (See Health Professions Program description in this catalog for more information.) Chemistry is particularly attractive to pre-law majors anticipating a career in a legal department in a chemical industry, in patent, intellectual property or environmental law. Students interested in industrial careers often combine their chemistry program with undergraduate courses in business administration or go on to study for an M.B.A.

The Department offers two degrees: the B.S. and the B.A. One third of the courses for the B.A. degree are free electives that may be taken in any of the departments of the University and therefore offer a high degree of flexibility. For the B.S. degree, electives normally are technical courses in chemistry or related fields of sciences, such as biology, physics, mathematics, or computer science, although they can be in other non-technical areas as well. It is possible to have all of the technical requirements completed after the junior year, allowing students the flexibility to combine electives in the senior year into a focused program of specialization. One of these programs is the B.S. in chemistry with the computational chemistry track. The track is an intense concentration in coursework related to scientific computing. Students interested in graduate studies in chemistry may enroll in graduate lecture courses. Those desiring immediate job placement may be interested in one or more of the formal options that supplement the chemistry B.S. degree. These are described in detail later. Carnegie Mellon has one of the strongest polymer science programs in the country and the undergraduate polymer science option offers training that is particularly valuable for an industrial career. The Computational Chemistry track provides students with expertise in scientific computing that is highly sought after by employers in the pharmaceutical industry.

An honors program is offered for highly motivated undergraduates. It is designed primarily for students who wish to undertake a strong research-intensive program of study in contemporary chemistry. The program "B.S. in Chemistry with Departmental Honors" requires the completion of at least one graduate level course, a research project, and the writing of a bachelor's honors thesis. An advanced track leading to the B.S. in Chemistry with Departmental Honors together with a Masters Degree in Chemistry involves completion of five graduate level courses and a more extensive thesis research

project. This track is especially attractive to students who have earned advanced placement credit in one or more science and/or mathematics courses at Carnegie Mellon. With enough advanced placement credit or by carrying heavier than usual course loads, students can complete the Honors/M.S. degree program in 8 semesters.

Additional majors (double majors) are available with nearly all other departments provided the student can fit the required courses into the schedule. Generally, all the requirements for both departments must be met for an additional major (except for some courses with similar content). Students interested in biochemistry, for example, could pursue a B.S. in Chemistry with an Additional Major in Biological Sciences. Programs are also available that lead to the degree B.S. in Chemistry with a minor in another discipline such as biological sciences, physics, mathematics, computer science, engineering studies, business administration and certain departments in the H&SS (Humanities and Social Sciences) college. Requirements for most minor programs are described by individual departments in this catalog. However, it is recommended that students who are interested in pursuing a minor as part of their degree consult with the department involved for current requirements and further guidance. Dual degree programs are available in which students receive two separate undergraduate degrees from two different departments in the University. These require students to complete at least 90 units of work per additional degree in addition to the units required for the first degree. Several five-year programs have been developed to allow a Carnegie Mellon undergraduate student to earn both a B.S. in Chemistry and a Master of Science degree in fields such as Health Care Policy and Management or Biotechnology Management.

Study abroad exchange programs are available for chemistry majors and programs of one to two semesters can generally be accommodated without delaying time to graduation beyond 8 semesters. One example of a formal exchange program is spending two semesters at École Polytechnique Fédérale de Lausanne (EPFL) in Switzerland. A language program of 3 months duration during the summer is available to students at no extra tuition cost. Study abroad is encouraged by the chemistry department and also can be arranged on an individual basis at universities in Europe, Asia, New Zealand, and Australia during both the academic year and the summer. Students interested in study abroad should consult with their academic advisor and the University's Study Abroad Advisor.

One of the most attractive features of the Department of Chemistry is the opportunity for students to interact with prominent research scientists in entry-level as well as advanced courses and in research. Since the spring of 2003, undergraduate laboratory instruction takes place in a new state-of-the-art facility. Participation in undergraduate research is encouraged and qualified students may begin projects as early as their second year. Approximately 80 to 90% of the graduating chemistry majors have taken part in research either for pay or for credit as part of their undergraduate training. Chemistry majors have been very successful in obtaining Small Undergraduate Research Grants (SURG) from the University to help support their research projects. Undergraduate and research laboratories are equipped with the latest scientific instrumentation. The use of computers is emphasized throughout the curriculum.

Curriculum – B.S. in Chemistry

The MCS curriculum requires seven Science Core Courses to be completed by the end of the junior year. These are: 21–120 (Differential and Integral Calculus), 21–122 (Integration, Differential Equations and Approximation), 33–111 (Physics I for Science Students), 33–112 (Physics II for Science Students), 09–105 (Introduction to Modern Chemistry), 03–121 (Modern Biology), and 15–100* (Introductory/Intermediate Programming). In the sample curriculum given below for chemistry majors, six of these are in the first year. Students should take the last Science Core Course as early as possible and by the end of their sixth semester. Course 09–106 (Modern Chemistry II) is defined as a Technical MCS Elective.

First Year

	Fall (Four Course Schedule)	Units
09-105	Introduction to Modern Chemistry	10
21-120	Differential and Integral Calculus	10
33-111	Physics I for Science Students	12
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3

Students interested in majoring in chemistry should consider enrolling in the 3-unit lab course 09-101, Introduction to Experimental Chemistry, in the fall or spring semester of the freshman year. Although not required, the laboratory course is recommended for chemistry majors.

	Spring	Units
09-106	Modern Chemistry II	10
21-122	Integration, Differential Equations and Approximation	10
33-112	Physics II for Science Students	12
15-100	Introductory/Intermediate Programming (or core elective)	10
xx-xxx	H&SS Distribution Course 1	9

Sophomore Year

	Fall	Units
09-201	Undergraduate Seminar I	1
09-219	Modern Organic Chemistry I	10
09-221	Laboratory I: Introduction to Chemical Analysis	12
09-231	Mathematical Methods for Chemists	9
03-121	Modern Biology (or core elective)	9
xx-xxx	H&SS Distribution Course 2	9

	Spring	Units
09-202	Undergraduate Seminar II	1
09-204	Professional Communication Skills in Chemistry	3
09-220	Modern Organic Chemistry II	10
09-222	Laboratory II: Organic Synthesis and Analysis	12
09-348	Inorganic Chemistry	10
xx-xxx	H&SS Distribution Course 3	9

Junior Year

	Fall	Units
09-301	Undergraduate Seminar III	1
09-321	Laboratory III: Molecular Design and Synthesis	12
09-344	Physical Chemistry (Quantum)	9
09-331	Modern Analytical Instrumentation	9
xx-xxx	H&SS/CFA Elective 1 (of 4)*	9

	Spring	Units
09-302	Undergraduate Seminar IV	1
09-322	Laboratory IV: Molecular Spectroscopy and Dynamics	12
09-345	Physical Chemistry (Thermo)	9
09-xxx	Chemical Elective (see Notes on Electives)	9
xx-xxx	H&SS/CFA Elective 2 (of 4)*	9

Senior Year

	Fall	Units
09-401	Undergraduate Seminar V	1
09-xxx	Chemical Elective (see notes on electives)	9
xx-xxx	Free Electives	27
xx-xxx	H&SS/CFA Elective 3 (of 4)*	9

	Spring	Units
09-402	Undergraduate Seminar VI	3
xx-xxx	Electives	36
xx-xxx	H&SS/CFA Elective 4 (of 4)*	9

* Certain non-technical courses from Business Administration, Heinz School, and EPP also may be used. A listing of approved and non-approved courses for the H&SS/CFA electives is available at the following web site, www.cmu.edu/mcs/education/edu_HSSFA.html, or see the Mellon College of Science section in this catalog for the Humanities and Social Sciences and Fine Arts Requirements. Accounting, finance, management, marketing, production, and statistics courses may NOT be used. Also, 70-100 (Introduction to Business) and 85-219 (Biological Foundations of Behavior) may NOT be used as electives in the H&SS/CFA category. If in doubt, check with your advisor.

Distribution of Units for the B.S. Degree
(and Requirements for An Additional Major
in Chemistry)

Minimum Total Chemistry Units (163; See distribution below)

Required Chemistry Courses*	Units	
09-105	Introduction to Modern Chemistry**	10
09-106	Modern Chemistry II	10
09-204	Professional Communication Skills in Chemistry	3
09-219	Modern Organic Chemistry I ****	10
09-220	Modern Organic Chemistry II ****	10
09-231	Mathematical Methods for Chemists***	9
09-331	Modern Analytical Instrumentation	9
09-344	Physical Chemistry (Quantum)	9
09-345	Physical Chemistry (Thermo)	9
09-348	Inorganic Chemistry	10
09-221	Lab I: Introduction to Chemical Analysis	12
09-222	Lab II: Organic Synthesis and Analysis	12
09-321	Lab III: Molecular Design and Synthesis	12
09-322	Lab IV: Molecular Spectroscopy and Dynamics	12
09-xxx	Chemistry Seminars	8
09-xxx	Chemistry Electives	18

* These, plus 33-111 Physics I for Science Students and 33-112 Physics for Science Students II, are the required courses for students earning an additional major in chemistry.

** 09-107, Honors Chemistry, may be taken instead of 09-105.

*** 21-259, Calculus in Three Dimensions, and an additional Mathematics/Statistics Elective (see Notes on Electives below) can be taken to fulfill the requirement for 09-231.

**** Students who transfer into the department and have taken 09-217, Organic Chemistry I, and/or 09-218, Organic Chemistry II, will be required to complete units of 09-435, Independent Study in Chemistry, under the supervision of the instructor(s) for 09-219 and/or 09-220 in order to master the course content missed in this course sequence.

Other Requirements	Units
Biology	9
Computer Science	10
Mathematics	20
Physics	24
Humanities and Social Sciences or Fine Arts courses	72
Free Electives	61
Computing @ Carnegie Mellon	3

Minimum number of units required for the degree: 360

The above B.S. curriculum recommends a range of 40-51 units/semester to meet the minimum degree requirement. Students are strongly encouraged to take extra elective courses (except in the first semester of the freshman year) in whatever subjects they wish in order to enrich their backgrounds and enhance their educational experience.

Notes on Electives

Mathematics/Statistics Elective

The B.S. degree in Chemistry requires 09-231 (Mathematical Methods for Chemists) as the advanced math requirement. In order to provide some flexibility, a student may take 21-259 (Calculus in Three Dimensions) and one 9-unit mathematics or statistics elective course to fulfill this requirement. Recommended courses include (but are not necessarily limited to): 21-260 (Differential Equations), 21-127 (Concepts of Mathematics), or 36-247 (Statistics for Laboratory Sciences). Less mathematically rigorous courses in statistics such as 36-201 (Statistical Reasoning and Practice) and 36-202 (Introduction to Statistical Methods) can NOT be used towards fulfillment of this requirement. You should verify your selection with your advisor before completing your mathematics elective.

Chemistry Electives

A minimum of 18 units of chemical electives is required.

Chemistry electives can be satisfied by 09-445, Undergraduate Research, or by most other chemistry courses 09-3xx or higher, undergraduate or graduate, for which the student has the necessary prerequisites, or by 03-231/232 Biochemistry I. 09-435, Independent Study in Chemistry, may only be used to fulfill this

requirement with permission of the Director of Undergraduate Studies. Certain interdisciplinary courses (e.g. 39-xxx) relating to chemistry can also be used. The scheduling of these electives can vary and students should check with the department offering the course to see which courses are offered in any given year or semester and with the Director of Undergraduate Studies in the Department of Chemistry to ascertain whether the course is an acceptable chemistry elective.

Free Electives

Free electives are defined as including any course offered by Carnegie Mellon except those in science or engineering fields that are primarily intended for non-majors. A maximum of 9 units total of Physical Education and/or ROTC courses can be counted as free elective units. The Chemistry Department does not require technical electives.

Options for the B.S. in Chemistry

The curriculum for the degree Bachelor of Science in Chemistry permits students to take a number of elective courses in chemistry and other fields, particularly in the junior and senior years. Students may wish to complete a group of elective courses from several specialty areas, called "options," to complement their technical education. Each option will complement the Bachelor's degree in Chemistry and will provide students with expertise in a specific area not covered by the normal undergraduate curriculum. Options are noted on the student's transcript but not on the diploma.

For each of the following options, the student should refer to the previous description of the curriculum for the B.S. in chemistry. Required courses are unchanged, and the courses that should be taken as electives for each option are listed below. Chemistry courses within an option also count towards fulfillment of the chemistry elective requirement for the B.S. degree.

Biochemistry Option	Units
03-231/232 Biochemistry I	9
03-330 Genetics	9
03-344 Experimental Techniques in Biochemistry	12
xx-xxx Elective in Biochemistry*	

*Elective may be 03-439, Introduction to Biophysics, 03-740, Advanced Biochemistry, 09-518, Bioorganic Chemistry: Nucleic Acids and Carbohydrates or 09-519, Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry

Polymer Science Option	Units
09-502 Organic Polymer Chemistry	9
09-509 Physical Chemistry of Macromolecules	9
39-802 Colloids, Polymers and Surfaces Laboratory II	9-12
09-xxx Elective in Polymer Science	9

Elective may be 09-445, Undergraduate Research (polymer project), or an upper level course in polymer science such as 09-545, Polymer Rheology

Colloids, Polymers, and Surfaces Option (offered jointly with the Department of Chemical Engineering)

06-607 Physical Chemistry of Colloids and Surfaces	9
06-509 Physical Chemistry of Macromolecules	9
06-426 Experimental Colloid and Surface Science	9
06-466 Experimental Polymer Science	9

Materials Chemistry Option	Units
27-100 Materials in Engineering	12
27-201 The Structure of Materials	9

Two Elective Courses (from list below)	
27-202 Defects in Materials	(Fall, 9 units)
09-502 Organic Polymer Chemistry	(Spring, 9 units)
09-545 Polymer Rheology	(Fall, 9 units)
09-445 Undergraduate Research (in a materials area)	(Spring or Fall, 9 units)
09-509 Physical Chemistry of Macromolecules	(Fall, 9 units)
39-802 Colloids, Polymers, and Surfaces Lab	(Spring, 9 units)
09-511 Solid State Materials	(Spring, 9 units)
27-xxx Approved MSE Course	(Fall or Spring, 9 units)

Environmental Chemistry Option		Units
09-510	Introduction to Green Chemistry	9

Three Elective Courses (from the list below or other approved electives)

09-520	Global Atmospheric Chemistry	9
06-630	Atmospheric Chemistry, Air Pollution and Global Change	12
12-090	Technology and the Environment	9
12-251	Introduction to Environmental Engineering	9
12-651	Air Quality Engineering	9
12-655	Water Quality Engineering (Lab Recommended)	9
12-720	Water Resources Chemistry	12
19-420	Chemical Technologies, the Environment, and Society	9
19-422	Radiation, Health, and Policy	9

Only one of the 19-xxx courses can be applied to the Environmental Chemistry Option

Management Option		Units
70-101	Introduction to Business Management	9
70-122	Introduction to Accounting	9
70-364	Business Law (or 70-365 International Trade Law)	9
73-100	Principles of Economics	9

Computational Chemistry Option		Units
15-111	Intermediate/Advanced Programming	9
21-369	Numerical Methods	9
09-560	Computational Chemistry	12
xx-xxx	One Upper Level Computational Elective Course*	9

*A list of approved courses for the elective for this option will be maintained and updated periodically by the Department. At the present time the list includes the following courses, but the Department will consider requests for other appropriate courses.

03-510	Computational Biology	12
03-511	Computational Molecular Biology and Genomics	9
03-512	Computational Methods for Biological Modeling and Simulation	9
33-241	Introduction to Computational Physics	9
15-211	Fundamental Data Structures and Algorithms	12
09-702	Statistical Mechanics and Dynamics	12
09-701	Quantum Chemistry I	12

Note: The Chemistry/Computational Chemistry Track (described later) requires the completion of the two upper level Computer Science courses 15-211 and 15-251, while in the Computational Chemistry Option, 15-111 and 21-369 are taken in place of these two courses. Since both 15-211 and 15-251 are prerequisites for higher level computer science courses, students in the Computational Chemistry Option should note that they are essentially blocked from taking additional courses in the Computer Science Department as senior computing electives. Students who complete 15-211 but not 15-251 may count 15-211 towards the Computational Chemistry Option as the required elective. Students pursuing the Computational Chemistry Option must complete course 15-100 as part of their MCS computing requirement.

A student who completes the recommended courses for any of these options will receive a certificate from the Department of Chemistry at Commencement as formal evidence of the accomplishment and a notation of this will be made on the student's transcript.

B.S. in Chemistry with Departmental Honors

Outstanding students with an interest in research are encouraged to consider the Honors program by the beginning of the junior year. The program combines a modified B.S. curriculum with close faculty-student contact in an individual research project, concluding with the student's presentation and defense of a bachelor's honors thesis to the Honors Committee.

The B.S. in Chemistry with Departmental Honors curriculum follows the general sequence of courses that is listed for the B.S. degree. Students are strongly urged to complete all seven of the Science Core Courses as early as possible. The honors program specifies that one of the two chemistry electives be a 12-unit graduate course, and that of the remaining electives required, at least two be undergraduate research (18 units) and one be 09-455, Honors Thesis (6 units). Students will be encouraged to do more than the minimum amount of research, so stipends from the research advisor or other sources are sometimes available for summer B.S. honors research.

At any time before the fall term of the senior year, candidates for the B.S. in chemistry may apply to be admitted for candidacy to the Honors B.S. program. To be accepted, students will be expected to have shown excellent performance in class work — normally at least a 3.2 average. An Honors Committee, comprised of the department's undergraduate advisors will monitor and evaluate the progress of the student's research project. A written and oral progress report to the Honors Committee is required in the fall of the senior year. A written thesis suitable for an Honors B.S. degree is required and should be a clear exposition in proper scientific format of a research project done for at least 18 units of credit in 09-445, Undergraduate Research. In April of the senior year, the Honors Committee will evaluate all theses and will require that each student participate in a public oral presentation or defense of the thesis before it approves the Honors degree. Students completing the B.S. with Departmental Honors in Chemistry will be eligible for MCS Research Honors as well.

Honors B.S./M.S. Program in Chemistry

Outstanding students seeking an advanced degree are encouraged to apply for admission to the B.S./M.S. Honors program as early as they can but only after having made some progress on a research project that could eventually be suitable for production of a Master's level thesis. Most commonly, applications are submitted during the second half of the sophomore year or during the junior year. Participants will have the opportunity to earn in four years not only the degree B.S. in Chemistry with Departmental Honors, but also the degree Master of Science in Chemistry. This program is highly research intensive and is not appropriate for all students. Requirements include completing five graduate level courses as electives. (See notes on Honors B.S./M.S. electives.)

The schedule of courses for the B.S./M.S. program generally moves as many courses as possible forward in the curriculum, though this is not a requirement. When possible, all Science Core Courses should be completed in the freshman year. This gives the student the following advantages: 1) greater perspective in selection of a research advisor, 2) greater maturity in performing independent research, and 3) the possibility of initiating graduate course sequences in the junior year. Students can achieve this accelerated schedule through advanced placement and summer school.

The student is expected to keep the research advisor selected by May of the sophomore year for the duration of the thesis project. Summer thesis research for 10 weeks after the sophomore and junior years is strongly suggested to assist the student in completing research of sufficient quantity and quality to complete their thesis. Students normally will be given stipends for their summer work either by their research advisor or by competing for a summer fellowship. A minimum of 3 semesters of undergraduate research is required (normally 10 units/semester) as is participation in group seminars during the junior and senior years. Students must present their research at least twice at the Sigma Xi competition at Meeting of the Minds, the annual Carnegie Mellon undergraduate research symposium. In addition students must meet with the Honors Committee each fall to update the committee on their progress and in the fall of the senior year must prepare a written summary of their research progress to date (5 pages) and their plans for the academic year (1 page). This report must state clearly what stage the work is in; it must be clear which work is complete and ready for publication.

A Thesis Committee will be formed to monitor the progress of each student. The committee shall consist of at least one member of the Honors Committee, the student's research advisor and a third faculty member agreed upon by the student and advisor. This third member can be from another department or institution and can be tenure track, lecturer track or research track faculty. At the start of the spring semester of the senior year, the student must submit a draft of the introduction for their thesis and a detailed outline of their methods, results and discussion sections to the Director of Undergraduate Studies who also chairs the Honors Committee. This will be distributed by the department and reviewed by the student's Thesis Committee.

Each student is required to submit a formal Masters Degree dissertation to the Chemistry Department in April of the senior year or at least one week prior to the date set for the thesis defense. The Thesis Committee will evaluate the written thesis and students are required to present their final oral defense of the project before the Thesis Committee. The public defense is followed by a private question and answer session with the Thesis Committee. The dissertation, written in proper scientific format, should describe the research project in considerable detail and must withstand the scrutiny of the Honors Committee with respect to completeness.

It need not be as extensive nor contain the element of student originality characteristic of a Ph.D. thesis; however it must contain results and conclusions that are of a high enough quality to be accepted as a publication in a respected research journal. The student should refer to the ACS Style Guide for recommendations on appropriate presentation and formatting of written text, tables, graphs, and figures. As for all M.S. degree candidates in the Department, the dissertation must be approved by the faculty member in charge of the work.

Research productivity is the most important criterion for success at the evaluation points, but QPA is a strong secondary criterion. While we expect that most students will maintain a QPA of 3.5, a minimum of 3.2 must be maintained to remain in the program and will be acceptable only with a strong record of research. Candidates must also maintain a QPA of at least 3.0 in the five graduate level courses required for the degree.

Notes on Honors B.S./M.S. Electives

The B.S./M.S. Honors degree requires the completion of five graduate level courses. These normally are 12-unit courses. However, in order not to penalize interdisciplinary studies which may be essential to a good thesis, up to three of the five required graduate chemistry courses may be advanced undergraduate (9-unit) courses in MCS and/or CIT departments. All advanced undergraduate level courses used to satisfy this requirement must be approved by the Director of Undergraduate Studies.

Curriculum – B.S. with Departmental Honors / M.S. in Chemistry

First Year		Units
03-121	Fall Introduction to Modern Biology	9
09-105	Introduction to Modern Chemistry	10
21-120	Differential and Integral Calculus	10
33-111	Physics for Science Students I	12
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
		53

Students interested in majoring in chemistry should consider enrolling in the 3-unit lab course 09-101, Introduction to Experimental Chemistry, in the fall or spring semester of the freshman year. Although not required, the laboratory course is recommended for chemistry majors.

Spring		Units
09-106	Modern Chemistry II	10
21-122	Integration, Differential Equations and Approximation	10
33-112	Physics for Science Students II	12
15-100	Introductory/Intermediate Programming	10
xx-xxx	H&SS Distribution Course 1	9
		51

Sophomore Year

Fall		Units
09-218	Modern Organic Chemistry I	10
09-231	Mathematical Methods for Chemists	9
09-221	Lab I: Introduction to Chemical Analysis	12
09-201	Undergraduate Seminar I	1
xx-xxx	H&SS Distribution Course 2	9
		41

Spring		Units
09-202	Undergraduate Seminar II	1
09-204	Professional Communication Skills in Chemistry	3
09-222	Lab II: Organic Synthesis and Analysis	12
09-220	Modern Organic Chemistry II	10
09-348	Inorganic Chemistry	10
xx-xxx	H&SS Distribution Course 3	9
		45

Summer
10 weeks Honors Research recommended

Junior Year

	Fall	Units
09-301	Undergraduate Seminar III	1
09-321	Lab III: Organic Synthesis and Analysis	12
09-344	Physical Chemistry (Quantum)	9
09-331	Modern Analytical Instrumentation	9
09-445	Undergraduate Research	10
xx-xxx	H&SS/CFA Elective 1 (of 4)*	9

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	Spring	Units
09-302	Undergraduate Seminar IV	1
09-322	Lab IV: Molecular Spectroscopy and Dynamics	12
09-445	Undergraduate Research	10
09-xxx	Graduate Chemistry Course (see notes on Honors B.S./M.S. electives)	12
09-345	Physical Chemistry (Thermo)	9
xx-xxx	H&SS/CFA Elective 2 (of 4)*	9

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Summer

10 weeks Honors Research recommended

Senior Year

	Fall	Units
09-401	Undergraduate Seminar V	1
09-445	Undergraduate Research	10
09-xxx	Graduate Chemistry Course	12
09-xxx	Graduate Chemistry Course	12
xx-xxx	H&SS/CFA Elective 3 (Of 4)*	9

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	Spring	Units
09-402	Undergraduate Seminar IV	3
09-455	Honors Thesis	15
09-xxx	Graduate Chemistry Course	12
09-xxx	Graduate Chemistry Course	12
xxx-xxx	H&SS/CFA Elective 4 (of 4)*	9

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* Certain non-technical courses from Business Administration, Heinz School, and EPP also may be used. A listing of approved and non-approved courses for the H&SS/CFA electives is available at the following web site, www.cmu.edu/mcs/education/edu_HSSFA.html, or see the Mellon College of Science section in this catalog for the Humanities and Social Sciences and Fine Arts Requirements. Accounting, finance, management, marketing, production, and statistics courses may NOT be used. Also, 70-100 (Introduction to Business) and 85-219 (Biological Foundations of Behavior) may NOT be used as electives in the H&SS/CFA category. If in doubt, check with your advisor.

Distribution of Units for the B.S. with Honors/M.S. Degrees

Minimum Total Chemistry Units (250, See distribution below)

Required Chemistry Courses	Units
09-105 Introduction to Modern Chemistry**	10
09-106 Modern Chemistry II	10
09-204 Professional Communication Skills in Chemistry	3
09-219 Modern Organic Chemistry I ****	10
09-220 Modern Organic Chemistry II ****	10
09-231 Mathematical Methods for Chemists***	9
09-331 Modern Analytical Instrumentation	9
09-344 Physical Chemistry (Quantum)	9
09-345 Physical Chemistry (Thermo)	9
09-348 Inorganic Chemistry	10
09-221 Lab I: Introduction to Chemical Analysis	12
09-222 Lab II: Organic Synthesis and Analysis	12
09-321 Lab III: Molecular Design and Synthesis	12
09-322 Lab IV: Molecular Spectroscopy and Dynamics	12
09-xxx Chemistry Seminars	8
Undergraduate Research (2 summers also recommended)	30
Graduate chemistry courses (see notes on B.S./M.S. electives)	60
09-455 Honors Thesis	15

** 09-107, Honors Chemistry, may be taken instead of 09-105.

*** 21-259, Calculus in Three Dimensions, and an additional Mathematics/Statistics Elective (see Notes on Electives in the B.S.

in Chemistry section) can be taken to fulfill the requirement for 09-231.

**** Students who transfer into the department and have taken 09-217, Organic Chemistry I, and/or 09-218, Organic Chemistry II, will be required to complete units of 09-435, Independent Study in Chemistry, under the supervision of the instructor(s) for 09-219 and/or 09-220 in order to master the course content missed in this course sequence.

Other Requirements

Biology	9
Computer Science	10
Mathematics	20
Physics	24
Humanities and Social Sciences or Fine Arts courses	72
Computing @ Carnegie Mellon	3

Minimum number of units required for degrees: 388

B.S. in Chemistry/Computational Chemistry Track

The use of computers is ubiquitous in chemistry. Theoretical chemists run large "number-crunching" programs on supercomputers to understand and predict molecular structures, properties, and reactivity. Experimental physical chemists use computers to develop models to their data. Organic and inorganic chemists use computers to plan complex sequences of reactions and predict 3D structures and properties of molecules. Analytical chemists use microprocessors to control instruments and robots to perform repetitive processes.

Computer science will play a growing role in chemistry in the future, but very few people without a Ph.D. degree have the background in both fields that is necessary to make an impact. The B.S. in Chemistry/Computational Chemistry Track degree is a response to society's need for bachelor's degree scientists who can apply computational sophistication to the practical problems of science. It is simultaneously a response to the large number of students who want not merely to learn computer science, but to apply that expertise in a subject area that gives them an edge in the job market.

As the student builds expertise in chemistry by taking the full B.S. curriculum, elective courses are devoted to mathematics and computer science. This culminates with 09-560, Computational Chemistry, which affords an overview of the areas of overlap of computer science with chemistry.

The degree designation on the transcript of students who complete the requirements for this program is: B.S. in Chemistry/Computational Chemistry Track. The track is not noted on the diploma.

Curriculum – B.S. in Chemistry/Computational Chemistry Track

First Year

	Fall (Four Course Schedule)	Units
09-105	Introduction to Modern Chemistry	10
21-120	Differential and Integral Calculus	10
33-111	Physics I for Science Students	12
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3

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	Spring	Units
09-106	Modern Chemistry II	10
15-100	Introductory/Intermediate Programming	10
21-122	Integration, Differential Equations and Approximation	10
33-112	Physics II for Science Students	12
xx-xxx	H&SS Distribution Course 1	9

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Sophomore Year

	Fall	Units
09-201	Undergraduate Seminar I	1
09-219	Modern Organic Chemistry I	10
09-221	Lab I: Introduction to Chemical Analysis	12
21-127	Concepts of Mathematics	9
15-111	Intermediate/Advanced Programming	9
xx-xxx	H&SS Distribution Course 2	9

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Spring		
09-202	Undergraduate Seminar II	1
09-204	Professional Communication Skills in Chemistry	3
09-222	Lab II: Organic Synthesis and Analysis	12
09-220	Modern Organic Chemistry II	10
21-259	Calculus in Three Dimensions++	9
15-211	Fundamental Data Structures and Algorithms	12
xx-xxx	H&SS Distribution Course 3	9

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++ 09-231, Mathematical Methods for Chemists can be taken in lieu of 21-259. Note that 09-231 is offered only in the fall.

Junior Year

Fall		
09-301	Undergraduate Seminar III®	1
09-321	Lab III: Molecular Design and Synthesis	12
09-344	Physical Chemistry (Quantum)	9
09-331	Modern Analytical Instrumentation	9
15-251	Great Theoretical Ideas in Computer Science	12
xx-xxx	H&SS/CFA Elective 1 (of 4)*	9

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Spring		
09-302	Undergraduate Seminar IV®	1
09-322	Lab IV: Molecular Spectroscopy and Dynamics	12
09-345	Physical Chemistry II (Thermo)	9
xx-xxx	Computing Elective	9
03-121	Modern Biology	9
xx-xxx	H&SS/CFA Elective 2 (of 4)*	9

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® Note that for this track 09-301 and 302 are not formally required, however you are encouraged to attend. These two courses are required for all other programs in chemistry.

Senior Year

Fall		
09-401	Undergraduate Seminar V	1
09-560	Computational Chemistry**	12
09-xxx	Chemistry Elective	9
xx-xxx	Free Elective	9
xx-xxx	H&SS/CFA Elective 3 (of 4)*	9

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** Computational chemistry may only be offered biannually and may move between the spring and fall semesters. You need to consult with your advisor as to the best time to schedule this course.

Spring		
09-402	Undergraduate Seminar VI	3
09-348	Inorganic Chemistry	10
xx-xxx	Computing Elective	9
xx-xxx	Free Elective	9
xx-xxx	H&SS/CFA Elective 4 (of 4)*	9

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* Certain non-technical courses from Business Administration, Heinz School, and EPP also may be used. A listing of approved and non-approved courses for the H&SS/CFA electives is available at the following web site, www.cmu.edu/mcs/education/edu_HSSFA.html, or see the Mellon College of Science section in this catalog for the Humanities and Social Sciences and Fine Arts Requirements. Accounting, finance, management, marketing, production, and statistics courses may NOT be used. Also, 70-100 (Introduction to Business) and 85-219 (Biological Foundations of Behavior) may NOT be used as electives in the H&SS/CFA category. If in doubt, check with your advisor.

Each student in the Computational Chemistry Track is required to complete two upper level mathematics and/or computer science electives. These may be chosen from the following list of courses. Others may be used with departmental approval.

Upper level Computing Courses		Units
15-212	Principles of Programming	12
15-312	Comparative Languages	9
15-411	Compiler Design	12
15-412	Operating Systems	12
15-413	Software Engineering	12
15-381	Artificial Intelligence: Representation and Problem Solving	9

15-384	Artificial Intelligence: Robotic Manipulation	9
15-385	Artificial Intelligence: Computer Vision	9
15-462	Computer Graphics (or equivalent)	9
15-xxx	Approved Elective	9

Upper Level Mathematics Courses

21-369	Numerical Methods	9
21-228	Discrete Mathematics	9
21-301	Combinatorial Analysis (note 21-228 prerequisite)	9
21-xxx	Approved Elective	9

Distribution of Units for the B.S. in Chemistry/Computational Chemistry Track

Minimum Total Chemistry Units (155; See distribution below)

Required Chemistry Courses		Units
09-105	Introduction to Modern Chemistry**	10
09-106	Modern Chemistry II	10
09-204	Professional Communication Skills in Chemistry	3
09-219	Modern Organic Chemistry I ****	10
09-220	Modern Organic Chemistry II ****	10
09-331	Modern Analytical Instrumentation	9
09-344	Physical Chemistry (Quantum)	9
09-345	Physical Chemistry (Thermo)	9
09-348	Inorganic Chemistry	10
09-221	Lab I: Introduction to Chemical Analysis	12
09-222	Lab II: Organic Synthesis and Analysis	12
09-321	Lab III: Molecular Design and Synthesis	12
09-322	Lab IV: Molecular Spectroscopy and Dynamics	12
09-560	Computational Chemistry	12
09-xxx	Chemistry Seminars	6
09-xxx	Chemistry Elective	9

** 09-107, Honors Chemistry, may be taken instead of 09-105.

**** Students who transfer into the department and have taken 09-217, Organic Chemistry I, and/or 09-218, Organic Chemistry II, will be required to complete units of 09-435, Independent Study in Chemistry, under the supervision of the instructor(s) for 09-219 and/or 09-220 in order to master the course content missed in this course sequence.

Other Requirements

Biology	9
Computer Science	43
Mathematics	38
Physics	24
Humanities and Social Sciences or Fine Arts courses	72
Computing or Math Electives	18
Computing @ Carnegie Mellon	3

Minimum number of units for the degree: 362

The above B.S. curriculum recommends an average course load of 37-55 units/semester. The total units will exceed the 360 unit minimum, but students are strongly encouraged to take the extra elective courses in whatever subjects they wish in order to enrich their backgrounds and enhance their educational experience.

B.A. in Chemistry

The curriculum for the B.A. degree provides students with the opportunity to take a substantial number of elective and non-technical courses. Certain chemistry, math, and other technical courses required for the B.S. degree are replaced by free electives, making this degree an ideal choice for those who wish to earn an additional major with one of the departments in the College of Humanities and Social Sciences, College of Fine Arts, or with the Business Administration program, though this is not a requirement. It is also attractive for students wishing to pursue careers in dentistry or pharmacy, career paths that require a broader preparation at the undergraduate level. It is not possible to combine the B.A. degree in chemistry with an additional B.A. degree in another department in MCS (e.g. Biological Sciences). Students may earn one or more of the options as described for B.S. degree candidates, providing they complete the courses listed.

The suggested curriculum recommends that the required technical courses be completed at the earliest opportunity, however students have considerable flexibility to postpone these courses in favor of electives, allowing compatibility with the programs of other departments. In designing such programs for a minor or additional major with chemistry, students should note that certain required chemistry courses only are offered in specific semesters, not both. These include the fall-only courses: 09-219 (Modern Organic Chemistry I) and 09-321 (Laboratory III: Molecular Design and Synthesis); and the spring-only courses: 09-214 (Physical Chemistry), 09-220 (Modern Organic Chemistry II), 09-348 (Inorganic Chemistry), and 09-204 (Professional Communication Skills in Chemistry). Also, in some cases, a course that is normally scheduled for the fall may be changed to a spring course (or vice versa) due to a departmental curriculum change.

Curriculum – B.A. in Chemistry

First Year

Fall (Four Course Schedule)		Units
09-105	Introduction to Modern Chemistry	10
21-120	Differential and Integral Calculus	10
33-111	Physics I for Science Students	12
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
		44

Students interested in majoring in chemistry should consider enrolling in the 3-unit lab course 09-101, Introduction to Experimental Chemistry, in the fall or spring semester of the freshman year. Although not required, the laboratory course is recommended for chemistry majors.

Spring		Units
09-106	Modern Chemistry II	10
15-100	Introductory/Intermediate Programming	10
21-122	Integration, Differential Equations and Approximation	10
33-112	Physics II for Science Students	12
xx-xxx	H&SS Distribution Course 1	9
		51

Sophomore Year

Fall		Units
09-201	Undergraduate Seminar I	1
09-219	Modern Organic Chemistry I	10
09-221	Lab I: Introduction to Chemical Analysis	12
xx-xxx	Free Elective	9
xx-xxx	H&SS Distribution Course 2	9
		41

Spring		Units
09-202	Undergraduate Seminar II	1
09-204	Professional Communication Skills in Chemistry	3
09-220	Modern Organic Chemistry II	10
09-222	Lab II: Organic Synthesis and Analysis	12
09-214	Physical Chemistry	9
xx-xxx	H&SS Distribution Course 3	9
		44

Junior Year

Fall		Units
09-301	Undergraduate Seminar III	1
09-321	Lab III: Molecular Design and Synthesis	12
03-121	Modern Biology	9
09-xxx	Chemistry Elective	9
xx-xxx	Free Elective	9
xx-xxx	H&SS/CFA Elective 1 (of 4)*	9
		49

Spring		Units
09-302	Undergraduate Seminar IV	1
09-348	Inorganic Chemistry	10
09-xxx	Chemistry Elective	9
xx-xxx	Free Elective	9
xx-xxx	Free Elective	9
xx-xxx	H&SS/CFA Elective 2 (of 4)*	9
		47

Senior Year

Fall		Units
09-401	Undergraduate Seminar V	1
xx-xxx	Free Electives	36
xx-xxx	H&SS/CFA Elective 3 (of 4)*	9
		46

Spring		Units
09-402	Undergraduate Seminar VI	3
xx-xxx	Free Electives	28
xx-xxx	H&SS/CFA Elective 4 (of 4)*	9
		40

* Certain non-technical courses from Business Administration, Heinz School, and EPP also may be used. A listing of approved and non-approved courses for the H&SS/CFA electives is available at the following web site, www.cmu.edu/mcs/education/edu_HSSFA.html, or see the Mellon College of Science section in this catalog for the Humanities and Social Sciences and Fine Arts Requirements. Accounting, finance, management, marketing, production, and statistics courses may NOT be used. Also, 70-100 (Introduction to Business) and 85-219 (Biological Foundations of Behavior) may NOT be used as electives in the H&SS/CFA category. If in doubt, check with your advisor.

Distribution of Units for the B.A. Degree

Minimum Total Chemistry Units (124; See distribution below)

Required Chemistry Courses	Units	
09-105	Introduction to Modern Chemistry**	10
09-106	Modern Chemistry II	10
09-204	Professional Communication Skills in Chemistry	3
09-219	Modern Organic Chemistry I ****	10
09-220	Modern Organic Chemistry II ****	10
09-214	Physical Chemistry (or 09-344 or 09-345)	9
09-348	Inorganic Chemistry	10
09-221	Lab I: Introduction to Chemical Analysis	12
09-222	Lab II: Organic Synthesis and Analysis	12
09-321	Lab III: Molecular Design and Synthesis	12
09-xxx	Chemistry Seminars	8
09-xxx	Chemistry Electives	18

** 09-107, Honors Chemistry, may be taken instead of 09-105

**** Students who transfer into the department and have taken 09-217, Organic Chemistry I, and/or 09-218, Organic Chemistry II, will be required to complete units of 09-435, Independent Study in Chemistry, under the supervision of the instructor(s) for 09-219 and/or 09-220 in order to master the course content missed in this course sequence.

Other Requirements

Biology (03-121)	9
Computer Science (15-100)	10
Mathematics (21-120 and 21-122)	20
Physics (33-111(I) and 33-112(II))	24
Humanities and Social Sciences or Fine Arts courses	72
Free Electives	100
Computing @ Carnegie Mellon	3

Minimum number of units for the degree: 360

The above B.A. curriculum recommends an average course load of 40-51 units/semester. The total units will exceed the 360 unit

minimum, but students are strongly encouraged to take the extra elective courses in whatever subjects they wish in order to enrich their backgrounds and enhance their educational experience.

Notes on Electives

Chemistry Electives

A minimum of 18 units of chemical electives is required.

Chemical electives can be satisfied by 09-445, Undergraduate Research, or by most other chemistry courses 09-3xx or higher, undergraduate or graduate, for which the student has the necessary prerequisites, or by 03-231/232 Biochemistry I. 09-435, Independent Study in Chemistry, may only be used to fulfill this requirement with permission of the Director of Undergraduate Studies. Certain interdisciplinary courses (e.g. 39-xxx) relating to chemistry can also be used. The scheduling of these electives can vary and students should check with the department offering the course to see which courses are offered in any given year or semester and with the Director of Undergraduate Studies in the Department of Chemistry to ascertain whether the course is an acceptable chemistry elective.

Free Electives

Free electives are defined as including any course offered by Carnegie Mellon except those in science or engineering fields that are primarily intended for non-majors. A maximum of 9 units total of Physical Education and/or ROTC courses can be counted as free elective units. The Chemistry Department does not require technical electives.

Requirements for a Minor in Chemistry

In order for a student to receive the added designation "...with a Minor in Chemistry" in conjunction with a B.S. or B.A. degree from another (primary) department, the successful completion of six courses as distributed below is required. Students pursuing the minor must inform the Chemistry Department of their intentions in writing using the MCS form for declaration of a minor so that the minor designation can be approved prior to graduation. The form may be obtained in the department office, DH 1317 or from the MCS undergraduate web page.

A. Four Required Core Courses

- 09-106 Modern Chemistry II
- 09-221 Laboratory I: Introduction to Chemical Analysis
- 09-217 Organic Chemistry I
- Choice of one of the following courses*:
 - 09-348 Inorganic Chemistry
 - 09-344 Physical Chemistry (Quantum)
 - 09-345 Physical Chemistry (Thermo)
 - 09-347 Advanced Physical Chemistry**
 - 09-214 Physical Chemistry

*Courses in this group that are not used to satisfy Part A core courses (section 4) may be used to satisfy elective course requirements in part B below, if they are not required by the student's primary department. However the only combination of physical chemistry courses (09-344, 09-345, 09-347 and 09-214) that is allowed is 09-344 and 09-345.

**Enrollment in this course is only open to students majoring in chemical engineering.

B. Two Elective Courses from the following list.

- 09-344 Physical Chemistry (Quantum) or
- 09-214 Physical Chemistry
- 09-345 Physical Chemistry (Thermo)
- 09-348 Inorganic Chemistry
- 09-222 Laboratory II: Organic Synthesis and Analysis
- 09-218 Organic Chemistry II
- 03-231/232 Biochemistry I
- 09-xxx Approved Upper Level Chemistry Course

Courses in this section (part B above) can not be counted toward the minor if they are required in any way by the student's primary department or towards an additional major or minor other than as a free elective. For example, students majoring in Biological Sciences can not double count 09-214, 03-231 (or -232), 09-222, or 09-218 toward the elective courses for the minor in chemistry. Chemical engineering majors can not count 03-231 (or 03-232) or a chemistry course that is used to satisfy that department's required chemistry or advanced chem/biochem elective. Also, chemical engineering majors can not use 09-344, 09-345 or 09-214 due to the similarity of these courses to courses required by the

chemical engineering department. 09-231, Mathematical Methods for Chemists, does not count towards the minor in chemistry. The undergraduate research course, 09-445, and 09-435, Independent Study in Chemistry, cannot be used for the minor.

Other Programs

As part of the undergraduate degree program, chemistry majors have the opportunity to pursue various special programs at Carnegie Mellon to enrich their academic experience. These include but are not limited to: programs with the College of Fine Arts, Humanities and Social Sciences, the H. John Heinz School of Public Policy and Management; Interdisciplinary Majors and Minors including Health Care Policy and Management. For more details, see the Tailoring Your Education portion of the Mellon College of Science section in this catalog.

Faculty

CATALINA ACHIM, Associate Professor of Chemistry — Ph.D., Carnegie Mellon; Carnegie Mellon, 2001 —.

BRUCE A. ARMITAGE, Professor of Chemistry — Ph.D., University of Arizona; Carnegie Mellon, 1997—.

MARK E. BIER, Associate Research Professor and Director, Center for Molecular Analysis—Ph.D., Purdue University; Carnegie Mellon, 1996 —.

EMILLE BOMINAAR, Associate Research Professor — Ph. D., University of Amsterdam (The Netherlands); Carnegie Mellon, 1994—.

MARCEL P. BRUCHEZ, Associate Research Professor, Program Manager, Technology Center for Networks and Pathways—Ph.D., University of California, Berkeley; Carnegie Mellon, 2006—.

TERRENCE J. COLLINS, Thomas Lord Professor of Chemistry and Director, Institute for Green Oxidation Chemistry — Ph.D., University Auckland, (New Zealand); Carnegie Mellon, 1987 —.

SUBHA R. DAS, Assistant Professor of Chemistry — Ph. D., Auburn University; Carnegie Mellon, 2006 —.

NEIL M. DONAHUE, Professor of Chemistry and Chemical Engineering and Director, Center for Atmospheric Particle Studies—Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2000—.

REBECCA FREELAND, Associate Dean for Special Projects, Mellon College of Science and Associate Head, Department of Chemistry — Ph.D., Carnegie Mellon; Carnegie Mellon, 1993 —.

ROBERTO GIL, Associate Research Professor and Director, NMR Facility — Ph.D., Córdoba National University Córdoba, Argentina; Carnegie Mellon, 2002 —.

SUSAN T. GRAUL, Lecturer — Ph.D., Purdue University; Carnegie Mellon, 1992 —.

MICHAEL P. HENDRICH, Professor of Chemistry — Ph.D., University of Illinois; Carnegie Mellon, 1994 —.

COLIN HORWITZ, Research Professor — Ph.D., Northwestern University; Carnegie Mellon, 1993 —.

RONGCHAO JIN, Assistant Professor of Chemistry — Ph.D., Northwestern University; Carnegie Mellon, 2006 —.

PAUL J. KAROL, Professor of Chemistry — Ph.D., Columbia University; Carnegie Mellon, 1969 —.

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DANITH LY, Associate Professor of Chemistry — Ph.D., Georgia Tech; Carnegie Mellon, 2001 —.

MAUMITA MANDAL, Assistant Professor of Chemistry—Ph.D., Center for Cellular and Molecular Biology, Hyderabad, India; Carnegie Mellon, 2008—.

KRZYSZTOF MATYJASZEWSKI, University Professor and J.C. Warner Professor of Natural Sciences and Director, Center for Macromolecular Engineering — Ph.D., Polish Academy of Sciences; Carnegie Mellon, 1985—.

RICHARD D. MCCULLOUGH, Professor of Chemistry and Vice President of Research — Ph.D., Johns Hopkins University; Carnegie Mellon, 1990—.

ECKARD MÜNCK, Professor of Chemistry — Ph.D., Technical University of Darmstadt, (Germany); Carnegie Mellon, 1990—.

GARY D. PATTERSON, Professor of Chemistry — Ph.D., Stanford University; Carnegie Mellon, 1984—.

LINDA A. PETEANU, Associate Professor of Chemistry — Ph.D., University of Chicago; Carnegie Mellon, 1992—.

KAREN H. STUMP, Teaching Professor and Director of Undergraduate Studies and Director of Laboratories — M.S., Carnegie Mellon University; Carnegie Mellon, 1983—.

LEONARD VUOCOLO, Lecturer — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2006—.

GARRY F. P. WARNOCK, Associate Teaching Professor — Ph.D., University of Minnesota; Carnegie Mellon, 1997—.

NEWELL WASHBURN, Assistant Professor of Chemistry and Biomedical Engineering — Ph.D., University of California, Berkeley; Carnegie Mellon, 2004—.

PAUL M. WHITMORE, Research Professor of Chemistry; Director, Art Conservation Research Center — Ph.D., University of California, Berkeley; Carnegie Mellon, 1988—.

DAVID YARON, Associate Professor of Chemistry — Ph.D., Harvard University; Carnegie Mellon, 1992—.

Emeriti

GUY C. BERRY, University Professor of Chemistry and Polymer Science, Emeritus — Ph.D., University of Michigan; Carnegie Mellon, 1960—.

AKSEL A. BOTHNER—BY, University Professor of Chemistry, Emeritus — Ph.D., Harvard University; Carnegie Mellon, 1958 —.

ALBERT A. CARETTO, JR., Professor of Chemistry, Emeritus — Ph.D., University of Rochester; Carnegie Mellon, 1959—.

EDWARD F. CASASSA, Professor of Chemistry, Emeritus — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1956 —.

JOSEF DADOK, Professor of Chemical Instrumentation, Emeritus — Ph.D., Czechoslovak Academy of Sciences; Carnegie Mellon, 1967—.

MORTON KAPLAN, Professor of Chemistry — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1970—.

ROBERT L. KAY, Professor of Chemistry, Emeritus — Ph.D., University of Toronto; Carnegie Mellon, 1963 —.

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Courtesy

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GORDON RULE, Faculty of Biomedical Engineering and Chemistry; Professor of Biology — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1995 —.

JAMES SCHNEIDER, Faculty of Biomedical Engineering and Chemistry; Professor of Chemical Engineering — Ph.D., University of Minnesota; Carnegie Mellon, 1999 —.

ALAN S. WAGGONER, Faculty of Biomedical Engineering and Chemistry; Director, Molecular Biosensor and Imaging Center and NSF Science and Technology Center — Ph.D. University of Oregon; Carnegie Mellon University, 1982 —.

LYNN WALKER, Professor of Chemical Engineering and Chemistry — Ph.D., University of Delaware; Carnegie Mellon, 1997 —.

Department of Mathematical Sciences

Roy A. Nicolaidis, Head
John F. Mackey, Associate Head
Office: Wean Hall 6113

Mathematics provides much of the language and quantitative underpinnings of the natural and social sciences, and mathematical scientists have been responsible for the development of many of the most commonly used tools in business management as well as for laying the foundation for computational and computer science. The name of the Department of Mathematical Sciences reflects its tradition of outstanding research and teaching of applicable mathematics relating to these areas. Indeed, the Department is consistently ranked among the top 15 departments of Applied Mathematics and Mathematical Sciences. We also note that our Logic group was ranked number 5 nationally. These research strengths are reflected in the variety of options that the Department provides for its undergraduate majors.

The Department offers a B.S. in Mathematics degree and the B.S. in Mathematical Sciences degree with concentrations in Mathematics, Operations Research, Statistics, Discrete Mathematics and Logic, and Computational and Applied Mathematics.

The B.S. in Mathematics Curriculum is the least structured of our programs in recognition of the wide variety of interests that can be productively coupled with the study of mathematical sciences. It can be an appropriate choice for students planning for graduate study in mathematics or seeking to design their curriculum to take advantage of the many opportunities for a second major from another department in the University.

The Operations Research Concentration prepares students to enter an area expected to be among the growth occupations over the next decade. Mathematicians with a background in operations research are especially valuable in such diverse activities as project planning, production scheduling, market forecasting and finance. Such applications are found in virtually all industrial and governmental settings.

The Statistics Concentration prepares students to contribute to a wide variety of research areas. Applications range from experimental design and data analysis in the physical and social sciences, medicine and engineering, to modelling and forecasting in business and government, to actuarial applications in the financial and insurance industries. This is also a useful second major for students planning for graduate study and research in subject areas requiring a strong statistical background.

The Discrete Mathematics and Logic Concentration is designed to provide the necessary mathematical background for students who want to participate in the modern developments flowing from the computer. This concentration includes a strong component of computer science.

Finally, the Computational and Applied Mathematics Concentration provides the background needed to support the computational and mathematical analysis needs of a wide variety of businesses and industries and is well suited to students with an interest in the physical sciences and engineering.

The Department places great emphasis on the advising of students. This is critical if students are to make the most of their years at the University. Students are urged to work carefully with their advisor and other faculty to formulate their degree program. Study abroad is encouraged, and an interested student should investigate the opportunities available in the Undergraduate Options section of the catalog.

Special options within the Department

The Department offers special opportunities for the exceptionally well-prepared and intellectually ambitious student. These options are available to students from any department in the University.

Analysis

For selected Freshmen entering the University, we offer 21-131/132 Analysis I/II, a more rigorous version of the first two semesters of calculus. Typically, a student choosing the Analysis Option has mastered the operational aspects of calculus and now seeks a deeper conceptual understanding.

Mathematical Studies

Following the Analysis sequence, we offer 21-235/236 Mathematical Studies I/II. This pair of intensive courses is team taught with a typical enrollment of about 20 students, allowing for close contact with faculty. Mathematical Studies provides an excellent preparation for graduate study, with many of the participants taking graduate courses as early as their Junior year. Admission to Mathematical Studies is by invitation, and interested students should apply during the Spring of their Freshman year.

Honors Degree Program

This demanding program qualifies the student for two degrees: The Bachelor of Science and the Master of Science in Mathematical Sciences. This program typically includes the Mathematical Studies option. For students who complete the Mathematical Studies sequence, the Master of Science degree may be earned together with a Bachelor of Science from another department.

Interdisciplinary Programs

Several interdisciplinary options enable a student to combine mathematics with other disciplines.

The Bachelor of Science and Arts program allows a student to combine mathematics with study in any of the five schools in the College of Fine Arts.

The Science and Humanities Scholars program includes an option shared with the Statistics Department in the Humanities and Social Sciences College that leads to a BS in Mathematics and Statistics.

Finally, a joint program with the Heinz School of Public Policy and Management and the Tepper School of Business leads to the degree Bachelor of Science in Computational Finance.

These programs are described in the catalog section on interdisciplinary programs.

Curricula

For each concentration, we provide a list of the requirements and a suggested schedule that takes prerequisites into account. A Mathematical Science, Statistics, or Computer Science Elective refers to a course from any of the Departments of Mathematical Sciences, Statistics or Computer Science. The only restrictions on these electives are that a mathematical sciences course must be beyond the calculus sequence and a statistics course must have at least 36-225 as a prerequisite.

The first year of calculus is offered in a flexible format to allow placement of entering students appropriate for their background. In addition to the standard sequence 21-120 followed by 21-122, 21-121 allows students to start half-way through 21-120 and 21-123 allows students to start half-way through 21-122.

Mathematical Science majors are required to complete an introductory computer science course, either 15-100 or 15-111. Students who plan to take further computer science courses must complete 15-111.

An H&SS Elective refers to a course in the Humanities and Social Science requirements as described in the catalog section for the Mellon College of Science. A course listed as an Elective is a free elective with the only restriction that the maximum total of ROTC and Physical Education units that will be accepted for graduation is nine.

In addition to the courses in the suggested schedules below, a student majoring in mathematical sciences also takes the one unit course 21-201 Undergraduate Colloquium each semester of the Sophomore year. This course plays an important role in introducing students to career opportunities, graduate school preparation, and student and faculty research in the Department.

Mathematics Degree

This program is the most flexible available to our majors. The flexibility to choose eight electives within the major plus seven humanities courses and seven free electives allows the student to design a program to suit his or her individual needs and interests. The requirements for the Mathematics Degree are:

Mathematical Sciences

21-120	Differential and Integral Calculus
21-122	Integration, Differential Equations and Approximation
21-127	Concepts of Mathematics
21-201	Undergraduate Colloquium
21-228	Discrete Mathematics (or 21-301 or 21-484)
21-341	Linear Algebra I
21-259	Calculus in Three Dimensions
21-260	Differential Equations
21-355	Principles of Real Analysis I
21-356	Principles of Real Analysis II
21-373	Algebraic Structures

five Mathematical Sciences electives

Other courses

15-100	Introductory/Intermediate Programming
36-225	Introduction to Probability and Statistics I (or 21-325)

three Mathematical Sciences, Statistics, or Computer Science electives

MCS humanities, social science, and science core (114 units)

seven free electives

Suggested Schedule

Freshman Year

	Fall	Units
21-120	Differential and Integral Calculus	10
33-111	Physics for Science Students I	12
15-100	Introductory/Intermediate Programming	10
03-121	Modern Biology	9
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3

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Spring

21-122	Integration, Differential Equations and Approximation	10
21-127	Concepts of Mathematics	9
33-112	Physics for Science Students II	12
09-105	Intro to Modern Chemistry	10
xx-xxx	H&SS Elective	9

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Sophomore Year

	Fall	Units
21-228	Discrete Mathematics (or 21-301 or 21-484)	9
21-341	Linear Algebra I	9
21-259	Calculus in Three Dimensions	9
21-201	Undergraduate Colloquium	1
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9

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Spring

21-260	Differential Equations	9
21-201	Undergraduate Colloquium	1
xx-xxx	Mathematical Sci, Statistics, or Computer Sci Elective	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9

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Junior Year

	Fall	Units
21-355	Principles of Real Analysis I	9
36-225	Introduction to Probability and Statistics I (or 21-325)	9
xx-xxx	Mathematical Sci, Statistics, or Computer Sci Elective	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9

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Spring

21-356	Principles of Real Analysis II	9
21-373	Algebraic Structures	9
21-xxx	Mathematical Sciences Elective	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9

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Senior Year

Fall

	Units	
21-xxx	Mathematical Sciences Elective	9
21-xxx	Mathematical Sciences Elective	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9

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Spring

21-xxx	Mathematical Sciences Elective	9
21-xxx	Mathematical Sciences Elective	9
xx-xxx	Mathematical Sci, Statistics, or Computer Sci Elective	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9

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Minimum number of units for the degree: 360

Students preparing for graduate study in mathematics should consider the following courses as Mathematical Sciences electives, choosing among them according to the desired area of graduate study:

21-301	Combinatorics
21-342	Linear Algebra II
21-371	Functions of a Complex Variable
21-372	Partial Differential Equations
21-374	Field Theory
21-465	Topology and Geometry
21-470	Selected Topics in Analysis
21-476	Ordinary Differential Equations
21-484	Graph Theory
21-600	Mathematical Logic I
21-602	Introduction to Set Theory
21-620	Real Analysis
21-621	Introduction to Lebesgue Integration
21-651	General Topology
21-660	Numerical Analysis I

Note that courses 21-600 and above carry graduate credit. 600 level courses are designed as transitional courses to graduate study. A student preparing for graduate study should also consider undertaking an independent work. The Department offers 21-499 Undergraduate Research Topic and 21-599 Undergraduate Reading and Research for this purpose.

Operations Research Concentration

An operations research professional employs quantitative and computational skills toward enhancing the function of an organization or process. Students choosing this concentration will develop problem-solving abilities in mathematical and statistical modelling and computer-based simulation in areas such as network design, transportation scheduling, allocation of resources and optimization. In addition to courses in Mathematical Sciences and Statistics, a basic background in economics and accounting is included. Since problems in business and industry are often solved by teams, the program also includes a group project to be undertaken in the Senior year.

The requirements for the concentration in Operations Research are:

Mathematical Sciences

21-120	Differential and Integral Calculus
21-122	Integration, Differential Equations and Approximation
21-127	Concepts of Mathematics
21-201	Undergraduate Colloquium
21-228	Discrete Mathematics (or 21-484)
21-241	Matrix Algebra
21-259	Calculus in Three Dimensions
21-260	Differential Equations
21-292	Operations Research I
21-369	Numerical Methods
21-393	Operations Research II

Statistics

36-225	Introduction to Probability and Statistics I (or 21-325)
36-226	Introduction to Probability and Statistics II
36-401	Modern Regression
36-402	Topic in Data Analysis
36-410	Introduction to Probability Models

Depth Electives

The detailed curriculum below includes five depth electives. These are to be chosen from among the following. 21-355 is particularly recommended for a student planning to pursue graduate work.

15-211	Fundamental Data Structures and Algorithms
15-212	Principles of Programming
21-270	Introduction to Mathematical Finance
21-355	Principles of Real Analysis I
21-365	Projects in Applied Mathematics
21-366	Topics in Applied Mathematics
21-370	Discrete-Time Finance
21-373	Algebraic Structures
21-420	Continuous-Time Finance
21-484	Graph Theory
36-461	Statistics Topic
36-462	Topic in Statistics
36-495	Independent Study
70-371	Production and Operations Management
70-460	Mathematical Methods for Consulting
70-471	Logistics and Supply Chain Management
70-473	Modeling for Operations Management Applications

Other Courses

15-100	Introductory/Intermediate Programming
70-122	Introduction to Accounting
73-100	Principles of Economics
73-150	Microeconomics
73-200	Marcoeconomics

MCS humanities, social science, and science core (120 units, including 73-100, 73-150 and 73-250)

Five free electives

Suggested Schedule

Freshman Year

	Fall	Units
21-120	Differential and Integral Calculus	10
33-111	Physics for Science Students I	12
15-100	Introductory/Intermediate Programming	10
03-121	Modern Biology	9
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
		53
	Spring	
21-122	Integration, Differential Equations and Approximation	10
21-127	Concepts of Mathematics	9
33-112	Physics for Science Students II	12
09-105	Intro to Modern Chemistry	10
xx-xxx	H&SS Elective	9

Sophomore Year

	Fall	Units
21-228	Discrete Mathematics (or 21-484)	9
21-241	Matrix Algebra	9
21-259	Calculus in Three Dimensions	9
21-201	Undergraduate Colloquium	1
73-100	Principles of Economics	9
		37
	Spring	
21-260	Differential Equations	9
21-292	Operations Research I	9
21-201	Undergraduate Colloquium	1
70-122	Intro to Accounting	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9

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Junior Year

	Fall	Units
21-369	Numerical Methods	9
xx-xxx	Depth Elective	9
36-225	Introduction to Probability and Statistics I (or 21-325)	9
73-150	Microeconomics	9
xx-xxx	Elective	9
		45
	Spring	
xx-xxx	Depth Elective	9
36-226	Introduction to Probability and Statistics II	9
36-410	Introduction to Probability Models	9
xx-xxx	H&SS Elective	9
73-200	Macroeconomics	9

Senior Year

	Fall	Units
21-393	Operations Research II	9
xx-xxx	Depth Elective	9
36-401	Modern Regression	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
		45
	Spring	
36-402	Topic in Data Analysis	9
xx-xxx	Depth Elective	9
xx-xxx	Depth Elective	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9

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Statistics Concentration

Statistics is concerned with the process by which inferences are made from data. Statistical methods are essential to research in a wide variety of scientific disciplines. For example, principles of experimental design that assist chemists in improving their yields also help poultry farmers grow bigger chickens. Similarly, time series analysis is used to better understand radio waves from distant galaxies, hormone levels in the blood, and concentrations of pollutants in the atmosphere. This diversity of application is an exciting aspect of the field, and it is one reason for the current demand for well-trained statisticians.

The courses 36-225/226 Introduction to Probability and Statistics I/II taken in the Junior year serve as the basis for all further statistics courses. The course 21-325 is a more mathematical alternative to 36-225.

The Statistics Concentration is jointly administered by the Department of Mathematical Sciences and the Department of Statistics. The Department of Statistics considers applications for the master's program from undergraduates in the Junior year. Students who are accepted are expected to finish their undergraduate studies, using some electives in the Senior year to take courses recommended by the Department of Statistics. This will ensure a strong background to permit completion of the master's program in one year beyond the baccalaureate. The requirements for the Statistics Concentration are:

Mathematical Sciences

21-120	Differential and Integral Calculus
21-122	Integration, Differential Equations and Approximation
21-127	Concepts of Mathematics
21-201	Undergraduate Colloquium
21-228	Discrete Mathematics (or 21-301)
21-241	Matrix Algebra
21-259	Calculus in Three Dimensions
21-260	Differential Equations
21-292	Operations Research I
21-369	Numerical Methods
21-393	Operations Research II

Statistics

36-225	Introduction to Probability and Statistics I (or 21-325)
36-226	Introduction to Probability and Statistics II
36-401	Modern Regression
36-402	Topic in Data Analysis
36-410	Introduction to Probability Models

Depth Electives

The detailed curriculum below includes six depth electives. These are to be chosen from among the following including at least one statistics course. 21-355 is particularly recommended for student planning to pursue graduate study.

15-211	Fundamental Data Structures and Algorithms
15-212	Principles of Programming
21-270	Introduction to Mathematical Finance
21-355	Principles of Real Analysis I
21-365	Projects in Applied Mathematics
21-366	Topics in Applied Mathematics
21-370	Discrete-Time Finance
21-373	Algebraic Structures
21-420	Continuous-Time Finance
21-484	Graph Theory
36-461	Statistics Topic
36-462	Topic in Statistics
36-495	Independent Study

Other Courses

15-100	Introductory/Intermediate Programming
15-111	Intermediate/Advanced Programming
73-100	Principles of Economics

MCS humanities, social science, and science core (114 units, including 73-100) four free electives

Suggested Schedule

Freshman Year

	Units	
Fall		
21-120	Differential and Integral Calculus	10
33-111	Physics for Science Students I	12
15-100	Introductory/Intermediate Programming	10
03-121	Modern Biology	9
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
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53		

Spring		
21-122	Integration, Differential Equations and Approximation	10
33-112	Physics for Science Students II	12
09-105	Intro to Modern Chemistry	10
21-127	Concepts of Mathematics	9
xx-xxx	H&SS Elective	9
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Sophomore Year

	Units	
Fall		
21-228	Discrete Mathematics or (21-301)	9
21-241	Matrix Algebra	9
21-259	Calculus in Three Dimensions	9
21-201	Undergraduate Colloquium	1
73-100	Principles of Economics	9
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37		

Spring		
15-111	Intermediate/Advanced Programming	9
21-260	Differential Equations	9
21-292	Operations Research I	9
21-201	Undergraduate Colloquium	1
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
<hr/>		
46		

Junior Year

	Units	
Fall		
21-369	Numerical Methods	9
36-225	Introduction to Probability and Statistics I (or 21-325)	9
xx-xxx	Depth Elective	9
xx-xxx	Depth Elective	9
xx-xxx	H&SS Elective	9
<hr/>		
45		

Spring		
xx-xxx	Depth Elective	9
36-226	Introduction to Probability and Statistics II	9
36-410	Introduction to Probability Models	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
<hr/>		
45		

Senior Year

	Units	
Fall		
21-393	Operations Research II	9
36-401	Modern Regression	9
xx-xxx	Depth Elective	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective 4	9
<hr/>		
45		

Spring		
36-402	Topic in Data Analysis	9
xx-xxx	Depth Analysis	9
xx-xxx	Depth Analysis	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
<hr/>		
45		

Minimum number of units required for the degree: 360

Discrete Mathematics and Logic

Concentration

This concentration will enable the student to develop mathematical skills in the areas of discrete mathematics and mathematical logic while simultaneously preparing the student for graduate study in mathematics, computer science or related disciplines. Both discrete mathematics and logic have strong ties with theoretical computer science, philosophy and computer engineering. This concentration is particularly recommended for students planning careers in computer science or engineering who wish to improve their understanding of the mathematical foundation of recent and future technological advancements in these fields.

The requirements for the Discrete Mathematics and Logic Concentration are:

Mathematical Sciences and Computer Science: (122 units)

15-111	Intermediate/Advanced Programming
15-211	Fundamental Data Structures and Algorithms
15-212	Principles of Programming
21-120	Differential and Integral Calculus (or 21-131 Analysis I)
21-122	Integration, Differential Equations and Approximation (or 21-132 Analysis II)
21-127	Concepts of Mathematics
21-201	Undergraduate Colloquium
21-300	Basic Logic
21-301	Combinatorics
21-341	Linear Algebra I
21-355	Principles of Real Analysis I
21-374	Algebraic Structures
21-484	Graph Theory

Discrete Mathematics and Logic

Three of the following: (27 to 36 units)

21-229	Set Theory
21-374	Field Theory
21-441	Number Theory
80-410	Recursion and Hierarchies
21-602	Introduction to Set Theory
21-603	Introduction to Model Theory
21-610	Algebra I
21-700	Mathematical Logic II

Computer Science electives: (18 units)

Any two courses at the 300 level or above. The following are specifically suggested:

15-312	Foundations of Programming Languages
15-451	Algorithms, Design and Analysis
15-453	Formal Languages and Automata
17-651	Models of Software Systems

Students pursuing this concentration who minor in Computer Science must take two additional Computer Science courses at the 300 level or above to avoid excessive double counting.

Technical Electives: (36 units)

Any four Mathematical Sciences courses at the 300 level or above, or from the following list:

21-259	Calculus in Three Dimensions
21-260	Differential Equations
21-292	Operations Research I
36-217	Probability Theory and Random Processes

- 80-405 Game Theory
- 80-411 Proof Theory
- 80-481 Formal Semantics

Other Courses:

MCS Humanities, Science and Computer Skills Core: (114 units)
 Free Electives: (Sufficient to meet minimum requirement of 360 units.)

Suggested Schedule

Freshman Year		Units
Fall		
21-120	Differential and Integral Calculus	10
33-111	Physics for Science Students I	12
15-111	Intermediate/Advanced Programming	10
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
		44
Spring		
21-122	Integration, Differential Equations and Approximation	10
21-127	Concepts of Mathematics	9
33-112	Physics for Science Students II	12
09-105	Intro to Modern Chemistry	10
		41
Sophomore Year		Units
Fall		
15-211	Fundamental Data Structures and Algorithms	12
21-301	Combinatorics	9
21-341	Linear Algebra I	9
21-201	Undergraduate Colloquium	1
03-121	Modern Biology	9
xx-xxx	Humanities Elective	9
		49
Spring		
15-212	Principles of Programming	12
xx-xxx	Discrete Math/Logic	9
21-201	Undergraduate Colloquium	1
xx-xxx	Technical Elective	9
xx-xxx	Humanities Elective	9
xx-xxx	Humanities Elective	9
		49
Junior Year		Units
Fall		
15-xxx	Computer Science Elective	9
21-300	Basic Logic	9
21-355	Principles of Real Analysis I	9
xx-xxx	Humanities Elective	9
xx-xxx	Elective	9
		45
Spring		
15-xxx	Computer Science Elective	9
21-373	Algebraic Structures	9
21-484	Graph Theory	9
xx-xxx	Humanities Elective	9
xx-xxx	Elective	9
		45
Senior Year		Units
Fall		
xx-xxx	Discrete Math/Logic	9
xx-xxx	Technical Elective	9
xx-xxx	Humanities Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9
		45
Spring		
xx-xxx	Discrete Math/Logic	9
xx-xxx	Technical Elective	18
xx-xxx	Humanities Elective	9
xx-xxx	Elective	9
		45

Minimum number of units required for degree: 360

Computational and Applied Mathematics Concentration

This concentration is designed to prepare students for careers in business or industry requiring significant skills in computation and problem solving. Beginning at the level of quantifying or modelling a problem, students will develop skills in appropriate techniques for carrying the effort through to an effective solution. The free electives allow the student to develop an interest in a related area by completing a minor in another department, such as Engineering Studies, Economics, Information Systems or Business Administration.

The requirements for the Computational and Applied Mathematics Concentration are:

Mathematical Sciences: (101 Units)

- 21-120 Differential and Integral Calculus
- 21-122 Integration, Differential Equations and Approximation
- 21-127 Concepts of Mathematics
- 21-201 Undergraduate Colloquium
- 21-228 Discrete Mathematics (or 21-301 or 21-484)
- 21-241 Matrix Algebra
- 21-259 Calculus in Three Dimensions
- 21-260 Differential Equations
- 21-320 Symbolic Programming Methods
- 21-355 Principles of Real Analysis I
- 21-356 Principles of Real Analysis II (or 21-357)
- 21-369 Numerical Methods

Five of the following distribution courses:
 (A minimum of 45 units)

- 15-211 Fundamental Data Structure and Algorithms
- 21-292 Operations Research I
- 21-370 Mathematics of Finance
- 21-371 Functions of a Complex Variable
- 21-372 Partial Differential Equations
- 21-380 Introduction to Mathematical Modeling
- 21-393 Operations Research II
- 21-476 Ordinary Differential Equations
- 21-470 Selected Topics in Analysis *

* Topics have included (a student may take more than one):
 Calculus of Variations
 Finite Difference Equations

- 21-660 Introduction to Numerical Analysis I
- 21-690 Methods of Optimization
- 21-xxx Mathematical Science Elective
- 36-410 Elementary Applied Probability

Other Courses: (19 units)

- 15-111 Intermediate/Advance Programming
- 36-225 Introduction to Probability and Statistics I (or 21-325)

MCS humanities, science and computer skills course (114 units)
 Free electives: (sufficient to meet minimum of 360 units.)

Suggested Schedule

Freshman Year		Units
Fall		
21-120	Differential and Integral Calculus	10
33-111	Physics for Science Students I	12
15-111	Intermediate/Advanced Programming	10
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
		44
Spring		
21-122	Integration, Differential Equations and Approximation	10
21-127	Concepts of Mathematics	9
33-112	Physics for Science Students II	12
09-105	Intro to Modern Chemistry	10
xx-xxx	Humanities Elective	9
		50
Sophomore Year		Units
Fall		
03-121	Modern Biology	9
21-241	Matrix Algebra	9
21-259	Calculus in Three Dimensions	9
21-201	Undergraduate Colloquium	1
xx-xxx	Humanities Elective	9
xx-xxx	Elective	9

	Spring	
21-228	Discrete Mathematics (or 21-301 or 21-484)	9
21-260	Differential Equations	9
21-201	Undergraduate Colloquium	1
xx-xxx	Distribution Course	9
xx-xxx	Humanities Elective	9
xx-xxx	Elective	9

Junior Year

	Fall	Units
21-320	Symbolic Programming Methods	9
21-355	Principles of Real Analysis I	9
36-225	Introduction to Probability and Statistics I (or 21-325)	9
xx-xxx	Humanities Elective	9
xx-xxx	Elective	9

	Spring	
21-356	Principles of Real Analysis II	9
21-369	Numerical Methods	9
xx-xxx	Distribution Course	9
xx-xxx	Humanities Elective	9
xx-xxx	Elective	9

Senior Year

	Fall	Units
xx-xxx	Distribution Course	9
xx-xxx	Distribution Course	9
xx-xxx	Humanities Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9

	Spring	
xx-xxx	Distribution Course	9
xx-xxx	Humanities Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9

Minimum units required for degree: 360

Double Major Requirements

All degrees offered by the Department are available as a second major to students majoring in other departments. Interested students should contact the Department for further information and guidance. In general the requirements for a second major include all the required courses except the MCS core, free electives and 21-201 Undergraduate Colloquium.

The Minor in Mathematical Sciences

The Minor includes six courses. 21-127 Concepts of Mathematics is a prerequisite for 21-228 and recommended for 21-241. The minimum preparation required for 21-355 Principles of Real Analysis I is 21-120/122 or equivalent courses. Students planning to include 21-373 Algebraic Structures as a Mathematical Sciences Elective should choose 21-341 Linear Algebra I, 21-241 and 21-341 cannot both count toward the minor.

21-127	Concepts of Mathematics
21-228	Discrete Mathematics (or 21-301 or 21-484)
21-241	Matrix Algebra (or 21-341)
21-355	Principles of Real Analysis I
21-3xx	Mathematical Sciences Elective
21-3xx	Mathematical Sciences Elective

To avoid excessive double counting, the two Mathematical Science Electives may not also count toward the student's major.

A student who completes the Mathematical Studies sequence plus two recommended electives (typically 21-470 Topics in Analysis and 21-374 Field Theory) will receive a Minor in Mathematical Sciences. Excluded as acceptable electives are the following: 21-105, 21-111, 21-112, 21-120, 21-122, 21-259, and 21-260, and courses intended for H&SS or undergraduate business students, such as 21-110, 21-256 and 21-257.

Minor in Discrete Mathematics and Logic

This minor develops the fundamentals of discrete mathematics and logic necessary to understand the mathematical foundations of many computer related disciplines. Required courses are:

21-300	Basic Logic
21-301	Combinatorics
21-341	Linear Algebra I
21-484	Graph Theory

Two of the following:

21-229	Set Theory
21-374	Field Theory
21-441	Number Theory
21-602	Introduction to Set Theory
21-603	Introduction to Model Theory
21-610	Algebra I
21-700	Mathematical Logic II

The Honors Degree Program

This demanding program leads to an M.S. in Mathematical Sciences, normally in four years, in addition to the student's B.S. degree. The key element in the program is usually the Mathematical Studies sequence. Admission to the Honors Program, in the Junior year, requires an application. In the application process the Department will hold to the same high standards which apply to admission to any graduate program.

Honors Program Requirements:

21-901	Master Degree Research	18 units
	Five graduate mathematics courses	60 units

Each student in the honors degree program will have a thesis advisor in addition to his or her academic advisor. In practice, the student must start thinking about the thesis as early as possible. For this reason we include some thesis work, 3 units of 21-901 Master Degree Research, in the Fall semester of the Senior year to allow for exploratory work under supervision. The actual thesis work is then planned for the final semester with 15 units of 21-901 Master Degree Research.

The five graduate course must include at least one course from each of the following areas:

Analysis, e.g., Measure and Integration, Complex Analysis, Functional Analysis

Algebra, Logic, Geometry and Topology, e.g., Mathematical Logic I, Algebra I, General Topology, Discrete Mathematics, Commutative Algebra

Applied Mathematics, e.g., Introduction to Continuum Mechanics, Probability Measures, Probability Theory, Graphs and Network Flows, Ordinary Differential Equations, Methods of Optimization, Introduction to Numerical Analysis I.

Faculty

PETER B. ANDREWS, Professor of Mathematics — Ph.D., Princeton University; Carnegie Mellon, 1963—.

EGON BALAS, Thomas Lord University Professor of Operations Research — Ph.D., University of Brussels; Carnegie Mellon, 1968—.

ALBERT A. BLANK, Professor of Mathematics, Emeritus — Ph.D., New York University; Carnegie Mellon, 1969—.

TOM BOHMAN, Associate Professor of Mathematical Sciences — Ph.D., Rutgers University; Carnegie Mellon, 1998—.

DEBORAH BRANDON, Associate Teaching Professor of Mathematical Sciences— Ph.D., Carnegie Mellon University; Carnegie Mellon, 1991—.

CHARLES V. COFFMAN, Professor of Mathematics, Emeritus — Ph.D., Johns Hopkins University; Carnegie Mellon, 1962—.

GERARD CORNUEJOLS, University Professor of Operations Research and Mathematics — Ph.D., Cornell University; Carnegie Mellon, 1978—.

JAMES CUMMINGS, Associate Professor of Mathematical Sciences — Ph.D., Cambridge University; Carnegie Mellon, 1996—.

HASAN DEMIRKOPARAN, Assistant Teaching Professor— Ph.D., Michigan State University; Carnegie Mellon, 2005—.

TIMOTHY FLAHERTY, Assistant Teaching Professor — Ph.D., University of Pittsburgh, Carnegie Mellon, 1999—.

IRENE M. FONSECA, Mellon College of Science Professor of Mathematical Sciences — Ph.D., University of Minnesota; Carnegie Mellon, 1987—.

ALAN M. FRIEZE, Professor of Mathematical Sciences and Computer Science — Ph.D., University of London; Carnegie Mellon, 1987—.

IRINA GHEORGHICIUC, Assistant Teaching Professor — Ph.D., University of Pennsylvania; Carnegie Mellon, 2007—.

JAMES M. GREENBERG, Professor of Mathematical Sciences, Emeritus — Ph.D., Brown University; Carnegie Mellon, 1995—.

RAMI GROSSBERG, Associate Professor of Mathematics — Ph.D., Hebrew University of Jerusalem; Carnegie Mellon, 1988—.

MORTON E. GURTIN, Alumni Professor of Mathematical Sciences, Emeritus — Ph.D., Brown University; Carnegie Mellon, 1966—.

DAVID HANDRON, Assistant Teaching Professor — Ph.D., Rice University; Carnegie Mellon, 1999—.

DAVID C. HEATH, Professor of Mathematical Sciences, Emeritus — Ph.D., University of Illinois; Carnegie Mellon, 1997—.

WILLIAM J. HRUSA, Professor of Mathematical Sciences — Ph.D., Brown University; Carnegie Mellon, 1982—.

WEINING KANG, Nehari/Duffin Visiting Assistant Professor of Mathematical Sciences — Ph.D., University of California at San Diego; Carnegie Mellon, 2005—.

DAVID KINDERLEHRER, Professor of Mathematical Sciences — Ph.D., University of California at Berkeley; Carnegie Mellon, 1990—.

DMITRY KRAMKOV, Professor of Mathematical Sciences — Ph.D., Steklov Mathematical Institute; Carnegie Mellon, 2000—.

JOHN P. LEHOCZKY, Professor of Statistics and Mathematical Sciences; Dean, College of Humanities and Social Science — Ph.D., Stanford University; Carnegie Mellon, 1969—.

GIOVANNI LEONI, Associate Professor of Mathematical Sciences — Ph.D., University of Minnesota; Carnegie Mellon, 2002—.

RICHARD C. MACCAMY, Professor of Mathematics, Emeritus — Ph.D., University of California at Berkeley; Carnegie Mellon, 1956—.

JOHN MACKEY, Associate Teaching Professor of Mathematical Sciences, Associate Department Head of Mathematical Sciences — Ph.D., University of Hawaii; Carnegie Mellon, 2003—.

DANIELA MIHAI, Assistant Teaching Professor — Ph.D., University of Pittsburgh; Carnegie Mellon, 2007—.

RICHARD A. MOORE, Professor of Mathematics, Emeritus — Ph.D., Washington University; Carnegie Mellon, 1956—.

ROY A. NICOLAIDES, Professor of Mathematical Sciences; Head, Department of Mathematical Sciences — Ph.D., University of London; Carnegie Mellon, 1984—.

WALTER NOLL, Professor of Mathematics, Emeritus — Ph.D., Indiana University; Carnegie Mellon, 1956—.

MARION L. OLIVER, Associate Teaching Professor of Mathematical Sciences — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2004—.

DAVID R. OWEN, Professor of Mathematics — Ph.D., Brown University; Carnegie Mellon, 1967—.

ROBERT L. PEGO, Professor of Mathematical Sciences— Ph.D., University of California at Berkeley; Carnegie Mellon, 2004—.

OLEG PIKHURKO, Assistant Professor of Mathematical Sciences, — Ph.D., Cambridge University, Carnegie Mellon, 2003—.

AGOSTON PISZTORA, Associate Professor of Mathematical Sciences — Ph.D. ETH Zurich, Carnegie Mellon, 1996—.

KAVITA RAMANAN, Associate Professor of Mathematical Sciences — Ph.D., Brown University; Carnegie Mellon, 2003—.

JOHN W. SCHAEFFER, Professor of Mathematical Sciences — Ph.D., Indiana University; Carnegie Mellon, 1983—.

JUAN J. SCHÄFFER, Professor of Mathematics — Ph.D., Universität Zürich; Carnegie Mellon, 1968—.

ERNEST SCHIMMERLING, Associate Professor of Mathematical Sciences — Ph.D., University of California at Los Angeles; Carnegie Mellon, 1998—.

DANA SCOTT, Hillman University Professor of Computer Science, Philosophy, and Mathematical Logic, Emeritus — Ph.D., Princeton University; Carnegie Mellon, 1981—.

ROBERT F. SEKERKA, University Professor of Physics and Mathematics — Ph.D., Harvard University; Carnegie Mellon, 1969—.

STEVEN E. SHREVE, Professor of Mathematical Sciences — Ph.D., University of Illinois; Carnegie Mellon, 1980—.

DEJAN SLEPCEV, Assistant Professor of Mathematical Sciences — Ph.D., University of Texas at Austin; Carnegie Mellon, 2006—.

RICHARD STATMAN, Professor of Mathematical Sciences and Computer Science — Ph.D., Stanford University; Carnegie Mellon, 1984—.

SHLOMO TA'ASAN, Professor of Mathematical Sciences — Ph.D., Weizmann Institute; Carnegie Mellon 1994—.

LUC TARTAR, University Professor of Mathematical Sciences — Ph.D., University of Paris; Carnegie Mellon, 1987—.

GERALD L. THOMPSON, IBM Professor of Systems and Operations Research, Emeritus — Ph.D., Columbia University; Carnegie Mellon, 1959—.

RUSSELL C. WALKER, Teaching Professor of Mathematical Sciences — D.A., Carnegie Mellon University; Carnegie Mellon, 1984—.

NOEL S. WALKINGTON, Professor of Mathematical Sciences — Ph.D., University of Texas at Austin; Carnegie Mellon, 1989—.

WILLIAM O. WILLIAMS, Professor of Mathematical Sciences — Ph.D., Brown University; Carnegie Mellon, 1966—.

Department of Physics

Fred Gilman, Head
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Student Programs Office: Wean Hall 7319
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Physics, one of the basic sciences, has its origin in the irrepressible human curiosity to explore and understand the natural world. This fundamental urge to discover has led to the detailed understanding of a remarkable variety of physical phenomena. Our knowledge now encompasses the large-scale movement of galaxies, the minute motions within atoms and nuclei, and the complex structure of the assemblies of molecules that make life possible. The spectacular expansion of our comprehension of the physical world forms an impressive part of the intellectual and cultural heritage of our times. The opportunity to add to this heritage is an important source of motivation for young physicists. The application of discoveries in physics to the solution of complex modern technological problems offers a vast field in which physicists make decisive contributions. The interplay of pure and applied physics has always been fruitful and today ensures many rewarding career opportunities for physics students.

Carnegie Mellon's undergraduate curriculum in physics has been carefully designed to provide a firm knowledge of the basic principles of physics, an appreciation of a wide range of physical problems of current interest, and the capacity to formulate and solve new problems. In addition to classwork and problem solving, the curriculum includes studying physical phenomena in the laboratory. Physics students are strongly encouraged to go beyond the formal theoretical and experimental course work and become involved in research projects under the guidance of individual faculty members.

Students may choose from a variety of degree options:

- B.S. in Physics
- B.A. in Physics
- B.S. in Physics with Tracks in:
 - Applied Physics
 - Astrophysics
 - Biological Physics
 - Chemical Physics
 - Computational Physics

The objectives and requirements for each of these options are described in the paragraphs below. Each allows considerable latitude in the choice of electives.

Through the judicious choice of elective courses, a double major program combining physics and another discipline can be readily achieved. A minor in physics is also offered for those students who major in other disciplines. The student, with the help of their faculty advisors, can easily build a program that aims at specific career objectives.

The Department maintains an active and wide-ranging program of advising. Beyond aiding in academic planning, Department advisors can also assist students in finding research work during the academic year, technical jobs and internships for the summer, as well as planning and executing the necessary steps for gaining employment or continuing their studies beyond the bachelor's degree. Whether students follow a standard curriculum or not, they should consult their academic advisor at least once every semester.

B.S. in Physics

B.S. degree candidates can choose not only from a wide variety of intermediate and advanced topics in physics, but also from a range of material in other science or engineering fields. The B.S. degree provides a solid foundation for students wishing to go on to graduate work in physics or any of a large number of fields in pure or applied science or engineering, for which a sound grasp of physics and mathematics is essential. This program also provides excellent preparation for careers in teaching, for work in industrial or governmental research and development, or for other employment in business or industry with a significant scientific component.

Requirements

Physics Courses		Units
33-104	Experimental Physics ⁽¹⁾	9
33-111	Physics I for Science Students	12
	or-	
33-131	Matter and Interactions I	12
33-112	Physics II for Science Students	12
	or	
33-132	Matter and Interactions II	12
33-201, 202	Physics Sophomore Colloquium I and II (2 units each)	4
33-301, 302	Physics Upper Class Colloquium III and IV (1 unit each)	2
33-211	Physics III: Modern Essentials	10
33-228	Electronics	10
33-231	Physical Analysis	9
33-232	Mathematical Methods of Physics	9
33-234	Quantum Physics	10
33-331	Physical Mechanics I	10
33-338	Intermediate Electricity and Magnetism I	10
33-340	Modern Physics Laboratory	10
33-341	Thermal Physics I	10

Physics Electives - at least 36 units ^{(2),(3)}

Minimum Total Physics Units ⁽⁴⁾ 163

Mathematics Courses

21-120	Differential and Integral Calculus	10
21-122	Integration, Differential Equations and Approximation	10
21-259	Calculus in Three Dimensions	9

Mathematics Elective (at least 9 units) ⁽⁵⁾ 9

Total Mathematics Units⁽⁴⁾ 38

Mellon College of Science Core ⁽⁷⁾

03-121	Modern Biology	9
09-105	Introduction to Modern Chemistry	10
15-100	Introductory/Intermediate Programming	10
99-10x	Computing @ Carnegie Mellon	3

Total MCS Core 32

Humanities, Social Sciences, or

Fine Arts Courses ^{(4),(7)}	72
Technical Electives ^{(4),(8)}	27
Free electives ^{(4),(9)}	28

The minimum number of units required for this degree: 360

Notes:

- ⁽¹⁾ Experimental Physics must be taken no later than the fall semester of the sophomore year.
- ⁽²⁾ Qualifying electives in physics are listed below.
- ⁽³⁾ Students planning to undertake graduate study in physics are strongly advised to take Physical Mechanics II (33-332), Intermediate Electricity and Magnetism II (33-339), and Advanced Quantum Physics I and II (33-445, 33-446).
- ⁽⁴⁾ Any excess units earned in physics or mathematics courses count towards the technical units, and excess technical or H&SS/FA units count towards free elective units.
- ⁽⁵⁾ Chosen from any 21-2xx or higher level course except 21-350. Note that 33-232 may be taken instead of 21-260 as a prerequisite for any math course.
- ⁽⁶⁾ The MCS core courses may be taken in any order, but must be finished by the end of the junior year.
- ⁽⁷⁾ Humanities, Social Sciences and Fine Arts (H&SS/FA) requirements follow the Mellon College of Science guidelines.
- ⁽⁸⁾ Technical electives are any courses in MCS, SCS, Statistics, and CIT, and others explicitly approved by the Physics Department.
- ⁽⁹⁾ A free elective is any Carnegie Mellon course. However, a maximum of 9 units of physical education and/or military science and/or or StuCo courses may be taken as free electives.

Qualifying Electives in Physics for the B.S. Degree

Fall and Spring

		Units-
33-350	Undergraduate Research ⁽¹⁰⁾	Var.
33-398	Special Topics ⁽¹¹⁾	Var.
33-451	Senior Research ⁽¹⁰⁾	Var.
33-458	Special Problems in Computational Physics	Var.
33-499	Supervised Reading ⁽¹⁰⁾	Var.

Fall Only

33-224	Stars, Galaxies and the Universe	9
33-241	Introduction to Computational Physics	9
33-441/		
03-439	Introduction to Biophysics	9
33-445	Advanced Quantum Physics I	9
33-467	Astrophysics of Stars and the Galaxy	9
33-650	General Relativity	9

Spring Only

33-114	Physics of Musical Sound ⁽¹²⁾	9
33-332	Physical Mechanics II	10
33-339	Intermediate Electricity and Magnetism	10
33-342	Thermal Physics II	10
33-446	Advanced Quantum Physics II	9
33-448	Introduction to Solid State Physics	9
33-456	Advanced Computational Physics	9
33-466	Extragalactic Astrophysics and Cosmology	9

Fall Only (Alternate Years)

33-353	Intermediate Optics (2009, 2011)	12
33-355	Nanoscience and Nanotechnology (2008, 2010)	9

Spring Only (Alternate Years)

33-444	Introduction to Nuclear & Particle Physics(2009, 2011)	9
33-658	Quantum Computation (2010, 2012)	9

Graduate Courses

33-755	Quantum Mechanics I	12
33-756	Quantum Mechanics II	12
33-758	Quantum Computation	12
33-759	Introduction to Theoretical Physics	12
33-761	Classical Electrodynamics I	12
33-762	Classical Electrodynamics II	12
33-765	Statistical Mechanics	12
33-767	Biophysics: From Basic Concepts to Current Research	12
33-769	Quantum Mechanics III	12
33-770	Quantum Mechanics IV	12
33-771	Quantum Mechanics V	12
33-777	Introductory Astrophysics	12
33-779	Nuclear and Particle Physics I	12
33-780	Nuclear and Particle Physics II	12
33-783	Theory of Solids I	12

Notes

⁽¹⁰⁾Only one of the two research courses — 33-350 (at least 9 units) and 33-451 (at least 9 units) — may be used to satisfy a Physics elective requirement. A maximum of 9 units of the reading course 33-499 can be used to satisfy a Physics elective. Any exception requires prior approval from the department.

⁽¹¹⁾33-398 Special Topics is offered occasionally and focuses on a variety of different topics; recent topics have included String Theory and Nanoscience and Nanotechnology.

⁽¹²⁾33-114 serves as a qualifying physics elective for the BA program only. Any exception needs prior approval from the department.

B.S. in Physics – Sample Schedule

(No Track)

First Year

	Fall	Units
33-111	Physics I for Science Students	12
or		
33-131	Matter and Interactions I	12
15-100	Introductory Programming	10
21-120	Differential and Integral Calculus	10
99-101	Computing @ Carnegie Mellon	3
76-101	Interpretation and Argument (MCS Core 1 of 8)	9

33-112	Spring Physics II for Science Students	12
or		
33-132	Matter and Interactions II	12
33-104	Experimental Physics	9
21-122	Integration, Differential Equations and Approximation	10
xx-xxx	Humanities, Social Sciences, or Fine Arts Course (MCS Core 2 of 8)	9

Sophomore Year

	Fall	Units
33-211	Physics III: Modern Essentials	10
33-231	Physical Analysis	9
33-201	Physics Sophomore Colloquium I	2
21-259	Calculus in Three Dimensions	9
09-105	Introduction to Modern Chemistry	10
xx-xxx	H&SS/FA Course (MCS Core 3 of 8)	9

33-232	Spring Mathematical Methods of Physics	9
33-228	Electronics	10
33-234	Quantum Physics	10
33-202	Physics Sophomore Colloquium II	2
03-121	Modern Biology	9
xx-xxx	H&SS/FA Course (MCS Core 4 of 8)	9

Junior Year

	Fall	Units
33-331	Physical Mechanics I	10
33-338	Intermediate Electricity and Magnetism I	10
33-341	Thermal Physics I	10
33-301	Physics Upper Class Colloquium	1
xx-xxx	H&SS/FA Course (MCS Core 5 of 8)	9
xx-xxx	Physics, Technical, or Free Elective (1 of 10)	9

33-340	Spring Modern Physics Laboratory	10
33-302	Physics Upper Class Colloquium	1
xx-xxx	Physics, Technical or Free Elective (2 of 10)	9
xx-xxx	Physics, Technical or Free Elective (3 of 10)	9
xx-xxx	Physics, Technical or Free Elective (4 of 10)	9
xx-xxx	H&SS/FA Course (MCS Core 6 of 8)	9

Senior Year

	Fall	Units
21-xxx	Mathematics Elective	9
xx-xxx	Physics, Technical or Free Elective (5 of 10)	9
xx-xxx	Physics, Technical or Free Elective (6 of 10)	9
xx-xxx	Physics, Technical or Free Elective (7 of 10)	9
xx-xxx	H&SS/FA Course (MCS Core 7 of 8)	9

xx-xxx	Spring Physics, Technical or Free Elective (8 of 10)	9
xx-xxx	Physics, Technical or Free Elective (9 of 10)	9
xx-xxx	Physics, Technical or Free Elective (10 of 10)	9
xx-xxx	H&SS/FA Course (MCS Core 8 of 8)	9

B.A. in Physics

The Bachelor of Arts degree in Physics offers a flexible program that allows students to combine the study of Physics with the opportunity to do intensive work in substantive areas such as liberal arts, teaching, business or law. With 82 units of free electives, it is feasible for students to obtain, for example, a double major with a department in the College of Humanities and Social Sciences, the College of Fine Arts, or the Tepper School of Business. It is expected that students will focus their elective courses in a well defined academic area. Students must meet with the B.A. academic advisor and construct an approved plan of study.

The requirements for the B.A. degree follow those for the B.S. degree with the following modifications:

- 18 units of Physics electives are required
- No units of mathematics electives are required.
- No units of technical electives are required.

The minimum number of units required for this degree is 360.

B.S. in Physics / Applied Physics Track

The B.S. in Physics/Applied Physics Track is designed primarily for the student who wants to prepare for a career path that takes advantage of the diverse and expanding opportunities for employment in industrial and government laboratories with a B.S. degree. The program provides a solid foundation in the concepts of physics, as well as giving the student the experience and understanding of the application of these concepts.

The track is intended to enhance computing and laboratory skills, and to introduce the application of physics to those subjects of particular interest to the student. Since the possible subject areas for study are so varied, the track will be tailored to each student's needs within the framework described below. To that end, the student will first meet with the Assistant Head for Undergraduate Affairs to discuss interests and career goals and to choose computing, laboratory and applications electives that fulfill the requirements of the track.

The requirements for this track are the same as those listed above for the B.S. degree with the following changes:

Additions to the requirements listed for the B.S. in Physics:

- 33-448 Introduction to Solid State Physics (9 units)
- One course (at least 9 units) which strengthens the student's ability to use the computer as a tool in the research environment
- Two courses (at least 18 units), at least one of them in another department, which broaden the student's laboratory skills
- Two courses (at least 18 units), at least one of them in another department which give the student experience in applying basic physics principles to a variety of problems
- One research course (at least 9 units) - may be taken as either of the following two courses:

33-350	Undergraduate Research
33-451	Senior Research

The topic in the research course must be in Applied Physics to be approved by the Track Advisor. Under special circumstances, research for pay may count toward this requirement, though it cannot be counted toward the units required for graduation.

All courses chosen from the categories listed above must be pre-approved by the Track Advisor.

Modifications from the requirements listed for the B.S. in Physics:

- No units of Physics Electives are required
- No units of Technical Electives are required
- The free elective unit requirement is adjusted so that the minimum number of units required for this degree is 360.

B.S. in Physics / Astrophysics Track

The B.S. in Physics/Astrophysics Track provides an option for those Physics majors who either want to specialize in this subfield or plan careers in astronomy or astrophysics. Career paths may include postgraduate training in astronomy or astrophysics or proceeding directly to jobs in these fields. The program provides a thorough foundation in the core physics program with electives concentrating in astrophysics.

The requirements for this track are the same as those listed above for the B.S. degree with the following changes:

Additions to the requirements listed for the B.S. in Physics:

- 33-224 Stars, Galaxies and the Universe
- 33-467 Astrophysics of Stars and the Galaxy
- 33-466 Extragalactic Astrophysics and Cosmology
- One research course (at least 9 units) - may be taken as either of the following two courses:

33-350	Undergraduate Research
33-451	Senior Research

The topic in the research course must be in Astrophysics to be approved by the Track Advisor. Under special circumstances, research for pay may count toward this requirement, though it cannot be counted toward the units required for graduation.

Modifications from the requirements listed for the B.S. in Physics:

- No units of Physics Electives are required
- The free elective unit requirement is adjusted so that the minimum number of units required for this degree is 360.

B.S. in Physics / Biological Physics Track

The B.S. in Physics/Biological Physics Track combines a rigorous foundation in undergraduate physics with courses in Biological Physics and Chemistry. It is particularly suitable for students preparing for post-baccalaureate careers in the expanding areas of biological and medical physics or for graduate study in biophysics. The program is sufficiently flexible that it can be readily adapt to the requirements of individual students. The student will first meet with the Assistant Head for Undergraduate Affairs to discuss interests and career goals and then choose electives which fulfill the requirements of the track.

The Biological Physics Track includes a number of courses which are also requirements for the pre-medical program. Students interested in both the Biological Physics Track and the pre-medical program should consult with both the Assistant Head for Undergraduate Affairs in the Physics Department and the Director of the Health Professions Program for help in planning their programs.

The requirements for this track are the same as those listed above for the B.S. degree with the following changes:

Additions to the requirements listed for the B.S. in Physics:

- 33-441/03-439 Introduction to Biophysics
- 03-231 Biochemistry I
- 09-217 Organic Chemistry I
- 09-218 Organic Chemistry II
- Two courses (at least 18 units) in Biological Sciences, to be pre-approved by the Assistant Head for Undergraduate Affairs

Modifications from the requirements listed for the B.S. in Physics:

- Only 9 units of Physics Electives are required
- No units of Technical Electives are required
- The free elective unit requirement is adjusted so that the minimum number of units required for this degree is 360.

B.S. in Physics / Chemical Physics Track

The B.S. in Physics/Chemical Physics Track is designed for students wishing to have a strong grounding in physics along with a specialization in physical chemistry and/or chemical physics. It is particularly suitable for those students planning on graduate studies in physics with an emphasis on chemical physics or chemistry. The program is sufficiently flexible that it can be readily adapted to the requirements of individual students. The student will first meet with the Assistant Head for Undergraduate Affairs to discuss interests and career goals and then choose electives that fulfill the requirements of the track.

The Chemical Physics Track incorporates a number of courses which are also requirements for the pre-medical program. Students interested in both the Chemical Physics Track and the pre-medical program should consult both with their Physics Department advisor and the Director of the Health Professions Program for help in planning their programs.

The requirements for this track are the same as those listed above for the B.S. degree with the following changes:

Additions to the requirements listed for the B.S. in Physics:

- 09-106 Modern Chemistry II
- 09-344 Physical Chemistry I (Quantum)
- 09-345 Physical Chemistry II (Thermodynamics)
- Three courses (at least 27 units) in Chemistry, to be pre-approved by the Assistant Head for Undergraduate Affairs.

Modifications from the requirements listed for the B.S. in Physics:

- Only 9 units of Physics Electives are required
- No units of Technical Electives are required
- The free elective unit requirement is adjusted so that the minimum number of units required for this degree is 360.

B.S. in Physics / Computational Physics Track

The B.S. in Physics/Computational Physics Track is intended to fill the increasing demand for physics graduates who are skilled in computational and numerical techniques which are used in the analysis of physical problems and in subjects ranging from control and real-time programming to software engineering and compiler and operating systems design. The degree provides the student with a rigorous grounding in physics as well as in the foundations and practice of computer use as applied to scientific problems. Work is done on machines ranging from high level workstations through supercomputers.

The track program includes additional courses from the Mathematics and Computer Science Departments as well as special courses in computational physics from the Physics Department. The program is sufficiently flexible that it can be readily adapted to the requirements of individual students. The student will first meet with the Assistant Head for Undergraduate Affairs to discuss interests and career goals and then choose electives that fulfill the requirements of the track.

The requirements for this track are the same as those listed above for the B.S. degree with the following changes:

Additions to the requirements listed for the B.S. in Physics:

- 33-241 Introduction to Computational Physics
- 33-456 Advanced Computational Physics
- 21-127 Concepts of Mathematics
- 21-369 Numerical Methods
- 15-211 Fundamental Data Structures and Algorithms
- One of the following classes: 15-212 Principles of Programming, 15-213 Introduction to Computer Systems, 15-251 Great Theoretical Ideas

Modifications from the requirements listed for the B.S. in Physics:

- 18 units of Physics Electives are required
- No units of Mathematics Electives are required
- No units of Technical Electives are required
- The free elective unit requirement is adjusted so that the minimum number of units required for this degree is 360.

A Double Major or a Dual Degree in Physics with a Degree in another Department

Physics may be taken as a second major or for a second degree, with another department granting the primary degree. The rules of the Physics Department for these two options are distinct, as discussed below.

Double Major

In order to receive a Double Major in another subject and Physics — with a B.S. or B.A., alone or with any track — all requirements of the Physics degree and the particular physics track, as listed in the previous sections, must be fulfilled except:

- No units of Mathematics Elective are required
- No units of Technical Electives are required
- No units of Free Electives are required
- No H&SS/FA courses are required
- The following courses in the MCS core are not required: 03-121, 09-105, 99-101/102/103. However, 15-100 is still required.

Dual Degree

In order to receive a Dual Degree in another subject and Physics — with a B.S. or B.A. alone or with any track — all requirements of the Physics degree and the particular physics track, as listed in the previous sections, must be fulfilled. The non-technical requirement is as per the Mellon College of Science; however, any course used for another department's or college's core requirement may be double counted for this purpose. The number of units required is 90 more than the total units required by the department requiring the fewer total units.

The Minor in Physics

The Minor in Physics is designed to provide a solid foundation in physics at the introductory level, followed by elective courses which will familiarize the student with areas of modern physics, and the concepts and techniques employed therein. The sequence consists of two introductory level courses followed by five electives chosen from the list below. The choice of electives requires prior approval by the Department of Physics, and should be made in close consultation with the Physics Department Assistant Head for Undergraduate Affairs. The Department intends to be flexible and accommodate the student's specific interests. The minor is open to all students of the university, although students with non-calculus based majors should be aware of the mathematics requirements for many physics courses (21–120, 122, 259).

The Physics minor requires seven courses of at least 9 units each, of which four are required and three are electives.

Required Courses

I. Introductory Physics I

Choose one course:

33-106	Physics I for Engineering Students
33-111	Physics I for Science Students
33-131	Matter and Interactions I

II. Introductory Physics II

Choose one course:

33-107	Physics II for Engineering Students
33-112	Physics II for Science Students
33-132	Matter and Interactions II

III. Modern Physics

33-211	Physics III: Modern Essentials
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IV. Laboratory Experience

33-104	Experimental Physics
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Elective Courses

Choose three courses from among the following list:

33-114	Physics of Musical Sound
33-224	Stars, Galaxies and the Universe
33-225	Quantum Physics and Structure of Matter
33-228	Electronics
33-231	Physical Analysis
33-232	Mathematical Methods of Physics
33-234	Quantum Physics
33-241	Introduction to Computational Physics
33-331	Physical Mechanics I
33-332	Physical Mechanics II
33-338	Intermediate Electricity and Magnetism I
33-339	Intermediate Electricity and Magnetism II
33-340	Modern Physics Laboratory
33-341	Thermal Physics I
33-342	Thermal Physics II
33-350	Undergraduate Research
33-353	Intermediate Optics
33-355	Nanoscience and Nanotechnology
33-398	Special Topics
33-444	Introduction to Nuclear and Particle Physics
33-445	Advanced Quantum Physics I
33-446	Advanced Quantum Physics II
33-448	Introduction to Solid State Physics
33-451	Senior Research
33-456	Advanced Computational Physics
33-458	Special Problems in Computational Physics
33-466	Extragalactic Astrophysics and Cosmology
33-467	Astrophysics of Stars and the Galaxy
33-499	Supervised Reading
33-650	General Relativity
33-658	Quantum Computation

One of	
33-350	Undergraduate Research
33-451	Senior Research

Any substitution of these requirements for the minor must be pre-approved in writing by the Physics Department.

Faculty

ROY A. BRIERE, Associate Professor of Physics — Ph.D., University of Chicago; Carnegie Mellon, 1999—.

RUPERT CROFT, Associate Professor of Physics — Ph.D., Oxford University; Carnegie Mellon, 2001—.

MARKUS DESERNO, Associate Professor of Physics — Ph. D., University of Mainz, Germany; Carnegie Mellon, 2007—.

TIZIANA DIMATTEO, Associate Professor of Physics — Ph.D., University of Cambridge; Carnegie Mellon, 2004—.

RANDALL M. FEENSTRA, Professor of Physics — Ph.D., California Institute of Technology; Carnegie Mellon, 1995—.

THOMAS A. FERGUSON, Professor of Physics — Ph.D., University of California at Los Angeles; Carnegie Mellon, 1985—.

GREGG B. FRANKLIN, Professor of Physics, Associate Dean for Graduate Affairs, Mellon College of Science — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1984—.

STEPHEN GAROFF, Professor of Physics — Ph.D., Harvard University; Carnegie Mellon, 1988—.

KUNAL GHOSH, Teaching Professor of Physics, Assistant Head for Undergraduate Affairs, Department of Physics — Ph.D., Iowa State University; Carnegie Mellon, 2001—.

FREDERICK J. GILMAN, Buhl Professor of Physics, Head, Department of Physics — Ph.D., Princeton University; Carnegie Mellon, 1995—.

RICHARD E. GRIFFITHS, Professor of Physics — Ph.D., University of Leicester, U.K.; Carnegie Mellon, 1996—.

ROBERT B. GRIFFITHS, University Professor & Otto Stern Professor of Physics — Ph.D., Stanford University; Carnegie Mellon, 1964—.

RICHARD F. HOLMAN, Professor of Physics — Ph.D., Johns Hopkins University; Carnegie Mellon, 1987—.

GEORGE KLEIN, Associate Teaching Professor of Physics — Ph.D., New York University; Carnegie Mellon, 1993—.

MICHAEL J. LEVINE, Professor of Physics — Ph.D., California Institute of Technology; Carnegie Mellon, 1968—.

LING-FONG LI, Professor of Physics — Ph.D., University of Pennsylvania; Carnegie Mellon, 1974—.

MATHIAS LOSCHE, Professor of Physics — Ph.D., Technical University of Munich, 1986; Carnegie Mellon, 2005—.

BARRY B. LUOKKALA, Teaching Professor of Physics — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1990—.

SARA A. MAJETICH, Professor of Physics — Ph.D., University of Georgia; Carnegie Mellon, 1990—.

CURTIS A. MEYER, Professor of Physics — Ph.D., University of California, Berkeley; Carnegie Mellon, 1993—.

COLIN J. MORNINGSTAR, Associate Professor of Physics — Ph.D., University of Toronto; Carnegie Mellon, 2000—.

JOHN F. NAGLE, Professor of Physics and Biological Sciences — Ph.D., Yale University; Carnegie Mellon, 1967—.

MANFRED PAULINI, Associate Professor of Physics — Ph.D., University of Erlangen, Germany; Carnegie Mellon, 2000—.

JEFFREY B. PETERSON, Professor of Physics — Ph.D., University of California, Berkeley; Carnegie Mellon, 1993—.

BRIAN P. QUINN, Professor of Physics — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1988—.

IRA Z. ROTHSTEIN, Professor of Physics — Ph.D., University of Maryland at College Park; Carnegie Mellon, 1997—.

JAMES S. RUSS, Professor of Physics — Ph.D., Princeton University; Carnegie Mellon, 1967—.

REINHARD A. SCHUMACHER, Professor of Physics — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1987—.

ROBERT F. SEKERKA, University Professor of Physics and Mathematics — Ph.D., Harvard University; Carnegie Mellon, 1969—.

ROBERT M. SUTER, Professor of Physics — Ph.D., Clark University; Carnegie Mellon, 1981—.

ROBERT H. SWENDSEN, Professor of Physics, — Ph.D., University of Pennsylvania; Carnegie Mellon, 1984—.

STEPHANIE TRISTRAM-NAGLE, Associate Research Professor of Physics — Ph.D., University of California, Berkeley; Carnegie Mellon, 1982—.

HELMUT VOGEL, Professor of Physics — Ph.D., University of Erlangen-Nuremberg; Carnegie Mellon, 1983—.

MICHAEL WIDOM, Professor of Physics — Ph.D., University of Chicago; Carnegie Mellon, 1985—.

KRISTINA WOODS, Assistant Professor of Physics — Ph.D., Stanford University; Carnegie Mellon, 2007—.

Emeritus Faculty

LUC BERGER, Professor of Physics, Emeritus — Ph.D., University of Lausanne, Switzerland; Carnegie Mellon, 1960—.

RICHARD M. EDELSTEIN, Professor of Physics, Emeritus — Ph.D., Columbia University; Carnegie Mellon, 1960—.

ARNOLD ENGLER, Professor of Physics, Emeritus — Ph.D., University of Berne, Switzerland; Carnegie Mellon, 1962—.

JOHN G. FETKOVICH, Professor of Physics, Emeritus — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1959—.

LEONARD S. KISSLINGER, Professor of Physics, Emeritus — Ph.D., Indiana University; Carnegie Mellon, 1969—.

TRUMAN KOHMAN, Adjunct Professor of Physics, Emeritus — Ph.D., University of Wisconsin; Carnegie Mellon, 1948—.

ROBERT W. KRAEMER, Professor of Physics, Emeritus — Ph.D., Johns Hopkins University; Carnegie Mellon, 1965—.

JOHN A. RAYNE, Professor of Physics, Emeritus — Ph.D., University of Chicago; Carnegie Mellon, 1963—.

ROBERT T. SCHUMACHER, Professor of Physics, Emeritus — Ph.D., University of Illinois; Carnegie Mellon, 1957—.

NED S. VANDER VEN, Professor of Physics, Emeritus — Ph.D., Princeton University; Carnegie Mellon, 1961—.

LINCOLN WOLFENSTEIN, University Professor of Physics, Emeritus — Ph.D., University of Chicago; Carnegie Mellon, 1948—.

HUGH D. YOUNG, Professor of Physics, Emeritus — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1956—.

Joint Appointments and Courtesy Appointments

SHELLEY ANNA, Assistant Professor, Mechanical Engineering — Ph.D., Harvard University; Carnegie Mellon 2003—.

DAVID GREVE, Professor, Electrical and Computer Engineering — Ph.D., Lehigh University; Carnegie Mellon, 1982—.

MOHAMMAD F. ISLAM, Assistant Professor of Chemical Engineering — Ph.D., University of Pennsylvania; Carnegie Mellon, 2005—.

CRAIG MALONEY, Assistant Professor of Civil and Environmental Engineering — Ph.D., University of California, Santa Barbara; Carnegie Mellon, 2007—.

MORTON KAPLAN, Professor, Chemistry — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1970—.

MICHAEL E. MCHENRY, Professor, Materials Science and Engineering — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1989—.

BENOIT MOREL, Adjunct Senior Lecturer, Engineering and Public Policy — Ph.D., University of Geneva, Switzerland; Carnegie Mellon, 1993—.

JIAN-GANG ZHOU, Professor of Electrical and Computer Engineering — Ph.D., University of California San Diego; Carnegie Mellon, 1997—.

School of
Computer Science

School of Computer Science

Randy Bryant, Dean
 Klaus Sutner, Associate Dean for Undergraduate Education
 Mark Stehlik, Assistant Dean for Undergraduate Education
 Undergraduate Office: Wean 5101
<http://www.csd.cs.cmu.edu/education/bscs/>

Carnegie Mellon founded one of the first Computer Science departments in the world in 1965. Today, the Computer Science Department forms the centerpiece of the School of Computer Science, and is joined by the Entertainment Technology Center, the Human-Computer Interaction Institute, the Institute for Software Research International, the Language Technologies Institute, the Machine Learning Department, and the Robotics Institute. Together, these units make the School of Computer Science a world leader in research and education.

The B.S. program in Computer Science combines a solid core of Computer Science courses with the ability to gain substantial depth in another area through a required minor in a second subject. In addition, the curriculum provides numerous choices for science and humanities courses. As computing is a discipline with strong links to many fields, this provides students with unparalleled flexibility to pursue allied (or non-allied) interests. The curriculum's mathematics and probability component ensures that students have the formal tools to remain current as technologies and systems change, rather than be limited by a narrow focus on programming alone. At the same time, students gain insight into the practical issues of building and maintaining systems by participating in intensive project-oriented courses. Due to the tremendous number of ongoing research projects within the School, many students obtain part-time or summer jobs, or receive independent study credit, working on research while pursuing their undergraduate degree. Students seeking a research/graduate school career may pursue an intensive course of research, equivalent to four classroom courses, culminating in the preparation of a senior research honors thesis.

Students apply to, and are directly admitted into, the undergraduate program in Computer Science and, upon successful completion, are awarded a Bachelor of Science in Computer Science. Suitably prepared students from other Carnegie Mellon colleges are eligible to apply for internal transfer to the School of Computer Science and will be considered for transfer if space is available. Computation-oriented programs are also available within the Departments of Biology, Chemistry, Physics, Electrical and Computer Engineering, Information Systems, Philosophy, Psychology, and Design. Also, a double major in Human-Computer Interaction is available jointly with the College of Humanities & Social Sciences.

Curriculum — B.S. in Computer Science

Computer Science

15-111	Intermediate/Advanced Programming (students with no prior programming experience take 15-100 & 15-111)
15-123	Effective Programming in C and UNIX
15-128	Freshman Immigration Course
15-211	Fundamental Data Structures and Algorithms
15-212	Principles of Programming
15-213	Introduction to Computer Systems
15-251	Great Theoretical Ideas in Computer Science
15-451	Algorithm Design and Analysis

One Communications course:

15-221	Technical Communication for Computer Scientists
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One Applications elective:

15-323	Music Systems and Information Processing
15-381	Artificial Intelligence: Representation & Problem Solving
15-384	Robotic Manipulation
15-385	Computer Vision
15-413	Software Engineering
15-415	Database Applications
15-421	Web Commerce, Security and Privacy
15-437	Web Application Development
15-462	Computer Graphics
15-463	Computational Photography

15-482	Human Language Technologies
15-490	Computational Neuroscience
10-601	Machine Learning
16-362	Mobile Robot Programming Laboratory
xx-xxx	others as appropriate

One Programming elective:

15-312	Foundations of Programming Languages
15-317	Constructive Logic
17-651	Models of Software Systems
21-300	Basic Logic
80-311	Computability and Incompleteness
xx-xxx	others as appropriate

One Systems elective:

15-410	Operating System Design and Implementation
15-418	Parallel Computer Architecture and Programming
15-441	Computer Networks
18-447	Introduction to Computer Architecture
xx-xxx	others as appropriate

One Theory elective:

15-354	Computational Discrete Mathematics
15-355	Modern Computer Algebra
15-414	Bug Catching: Automated Program Verification and Testing
15-453	Formal Languages and Automata
21-301	Combinatorics
21-484	Graph Theory
xx-xxx	others as appropriate

Two Computer Science electives

Mathematics/Probability

21-120	Differential & Integral Calculus
21-122	Integration, Differential Equations, and Approximation
21-127	Concepts of Mathematics
21-241	Matrix Algebra (or 21-341, Linear Algebra)

One of the following Probability courses:

15-359	Probability and Computing
21-325	Probability
36-217	Probability Theory and Random Processes
36-225	Introduction to Probability and Statistics I
36-625	Probability and Mathematical Statistics I

Engineering and Natural Sciences

Four engineering or science courses are required, of which at least one must have a laboratory component and at least two must be from the same department. At present, courses meeting the lab requirement are:

09-101	Introduction to Experimental Chemistry (this 3 unit lab <u>together with</u> 09-105, Introduction to Modern Chemistry, satisfies the lab requirement)
15-321	Research Methods for Experimental Computer Science
27-100	Engineering the Materials of the Future
33-104	Experimental Physics
85-310	Research Methods in Cognitive Psychology

The following MCS and CIT courses cannot be used to satisfy the Engineering and Natural Sciences requirement:

09-103	Atoms, Molecules, and Chemical Change
09-104	Fundamental Aspects of Organic Chemistry and Biochemistry
12-090	Technology and the Environment
18-202	Mathematical Foundations of Electrical Engineering
33-100	Basic Experimental Physics
33-115	Energy and Environmental Issues
33-124	Introduction to Astronomy
39-100	What is Engineering?

Computing @ Carnegie Mellon

The following course is required of all students to familiarize them with the campus computing environment:
99-10x Computing @ Carnegie Mellon

Required Minor

A sequence of courses proscribed by the requirements of the particular department. Completion of a second major (or double degree) also satisfies this requirement. If permitted by the minor or second major department, courses taken in satisfaction of the minor or second major may also count toward any category other than Computer Science.

Humanities and Arts Requirements

All candidates for the bachelor's degree must complete a minimum of 63 units offered by the College of Humanities & Social Sciences and/or the College of Fine Arts. Carnegie Mellon is currently engaged in a university-wide examination of general education under the rubric of Integrative Liberal Studies. The School of Computer Science fully supports this examination and expects that, when this university-wide examination concludes, that our general education requirements will be different than they are in this catalog. For now, though, the general education courses for SCS students are to meet the following distribution requirements:

A. Writing Requirement (9 units)

Complete the following course:
76-101 Interpretation and Argument

B. Breadth Requirement (27 units)

Complete three courses, one each from Category 1, Category 2, and Category 3:

Category 1: Cognition, Choice and Behavior

- 70-311 Organizational Behavior
- 80-130 Introduction to Ethics
- 80-150 Nature of Reason
- 80-180 The Nature of Language
- 80-221 Philosophy of Social Science
- 80-230 Ethical Theory
- 80-241 Ethical Judgments in Professional Life
- 80-242 Conflict, Dispute Resolution
- 80-270 Philosophy of Mind
- 80-271 Philosophy and Psychology
- 80-281 Language and Thought
- 85-100 Introduction to Intelligence in Humans, Animals, and Machines
- 85-102 Introduction to Psychology
- 85-211 Cognitive Psychology
- 85-221 Principles of Child Development
- 85-241 Social Psychology
- 85-251 Personality
- 85-261 Abnormal Psychology
- 88-120 Reason, Passion and Cognition
- 88-260 Organizations

Category 2: Economic, Political and Social Institutions

- 36-303 Sampling, Survey and Society
- 70-332 Business, Society and Ethics
- 73-100 Principles of Economics
- 73-150 Principles of Economics with Calculus
- 79-223 Protest and Dissent in American History
- 79-331 Crime and Punishment
- 79-335 Drug Use and Drug Policy
- 79-345 American Environmental History: Critical Issues
- 79-350/
- 88-326 Theories of International Relations
- 80-135 Introduction to Political Philosophy
- 80-136 Social Structure, Public Policy and Ethical Dilemmas
- 80-235 Political Philosophy
- 80-236 Philosophy and the Law
- 80-243 Environment Management and Ethics
- 80-341 Computers, Society, and Ethics
- 88-104 Decision Processes in American Political Institutions
- 88-110 Experiments with Economic Principles
- 88-205 Comparative Politics
- 88-220 Policy Analysis I

Category 3: Cultural Analysis

- 57-173 Survey of Western Music History
- 70-342 Managing Across Cultures
- 76-227 Comedy
- 76-232 African-American Studies
- 76-239 Introduction to Film Studies

- 76-241 Introduction to Gender Studies
- 79-104 Introduction to World History
- 79-113 Culture and Identity in American Society
- 79-201 Introduction to Anthropology
- 79-206 Development of American Culture
- 79-207 Development of European Culture
- 79-209 Theory and Practice in Anthropology
- 79-218 The Roots of Rock & Roll
- 79-222 Religion in American Society
- 79-226 History and Cultures of East Asia
- 79-241 African-American History I
- 79-242 African-American History II
- 79-259 Introduction to Religion
- 79-270 Chinese Culture and Society
- 79-368 Poverty, Charity, and Welfare
- 79-384 Medicine and Society
- 80-100 What Philosophy Is
- 80-151 God in the West
- 80-250 Ancient Philosophy
- 80-251 Modern Philosophy
- 80-253 Continental Philosophy
- 80-254 Analytic Philosophy
- 80-255 Pragmatism
- 80-261 Aesthetics of Mass Art
- 80-276 Philosophy of Religion
- 82-273 Introduction to Japanese Language and Culture
- 82-294 Topics in Russian Language and Culture
- 82-303 French Culture
- 82-304 Francophone World
- 82-325 Introduction to German Studies
- 82-333 Introduction to Chinese Language and Culture
- 82-342 Spain: Language and Culture
- 82-343 Latin America: Language and Culture
- 82-344 US Latinos: Language and Culture
- 82-345 Hispanic Literary and Cultural Studies

C. Humanities and Arts Electives (27 units)

Complete 3 non-technical courses of at least 9 units each from any of the departments in the College of Humanities & Social Sciences or the College of Fine Arts or from the Department of Business Administration. Some of the courses taught in these units are considered technical courses and may not be used to satisfy this requirement. The complete list of currently acceptable and not acceptable courses can be found at <http://www.csd.cs.cmu.edu/education/bcs/hss.html>.

Free Electives

A free elective is any Carnegie Mellon course. However, a maximum of nine units of physical education and/or military science (ROTC) courses may be used toward fulfilling graduation requirements.

Summary of Degree Requirements:

Area	Courses	Units
Computer Science	14	148
Math/Statistics	5	47
Engineering/Science	4	36
Humanities/Arts	7	63
Minor/Free Electives	7	63
Computing @ Carnegie Mellon	1	3
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		360

Suggested Course Sequence:

Freshman Year

		Units
	Fall	
15-111	Intermediate/Advanced Programming	10
15-128	Freshman Immigration Course	1
21-120	Differential & Integral Calculus	10
21-127	Concepts of Mathematics	9
76-101	Interpretation and Argument	9
99-10x	Computing Skills Workshop	3
xx-xxx	Science/Engineering Course	9
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		51

Spring

15-211	Fundamental Data Structures and Algorithms	12
15-251	Great Theoretical Ideas in Computer Science	12
21-122	Integration, Differential Equations, and Approximation	10
xx-xxx	Science/Engineering Course	9
xx-xxx	Humanities and Arts Elective	9
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		52

Sophomore Year

Fall		Units
15-123	Effective Programming in C and UNIX	9
15-212	Principles of Programming	12
21-241	Matrix Algebra	9
xx-xxx	Science/Engineering Course	9
xx-xxx	Humanities and Arts Elective	9

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Spring

15-213	Introduction to Computer Systems	12
15-221	Technical Communication for Computer Scientists	9
15-xxx	Computer Science Elective	9
xx-xxx	Science/Engineering Course	9
xx-xxx	Minor Requirement / Free Elective	9

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Junior Year

Fall		Units
15-451	Algorithm Design and Analysis	12
15-xxx	Computer Science Elective	9
xx-xxx	Probability Course	9
xx-xxx	Humanities and Arts Elective	9
xx-xxx	Minor Requirement / Free Elective	9

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Spring

15-xxx	Computer Science Elective	12
15-xxx	Computer Science Elective	9
xx-xxx	Humanities and Arts Elective	9
xx-xxx	Minor Requirement / Free Elective	9

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Senior Year

Fall		Units
15-xxx	Computer Science Elective	12
xx-xxx	Humanities and Arts Elective	9
xx-xxx	Minor Requirement / Free Elective	9
xx-xxx	Minor Requirement / Free Elective	9

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Spring

15-xxx	Computer Science Elective	9
xx-xxx	Humanities and Arts Elective	9
xx-xxx	Minor Requirement / Free Elective	9
xx-xxx	Minor Requirement / Free Elective	9

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Minimum number of units required for the degree: 360

Suggested Options

The flexibility in the curriculum allows many different schedules, of which the above is only one possibility. For those students looking for some additional guidance in navigating their elective options, we offer the following recommendations of elective choices that might be made for particular concentrations.

Artificial Intelligence

15-381	Artificial Intelligence: Representation and Problem Solving
15-384/5	Robotic Manipulation / Computer Vision
15-486	Artificial Neural Networks
15-681	Artificial Intelligence: Machine Learning
80-300	Minds, Machines, and Knowledge
80-316	Probability and AI
85-211	Cognitive Psychology
85-213	Human Information Processing and Artificial Intelligence
85-419	Introduction to Parallel Distributed Processing

Cognitive Modeling

05-432	Cognitive Modeling and Intelligent Tutoring Systems
05-811	Cognitive Modeling for HCI
85-211	Cognitive Psychology
85-213	Human Information Processing and Artificial Intelligence
85-392	Human Expertise
85-412	Cognitive Modeling

Computer Systems

15-410	Operating System Design and Implementation
15-411	Compiler Design
15-412	Operating System Practicum
15-441	Computer Networks
15-610	Engineering Complex, Large-Scale Computer Systems
18-240	Fundamentals of Computer Engineering
18-447	Introduction to Computer Architecture

Entrepreneurship

15-390	Entrepreneurship for Computer Science
15-391	Technology Consulting in the Community

Graphics/Virtual Reality

05-331	Building Virtual Worlds
15-462	Computer Graphics
15-463	Computational Photography
15-464	Technical Animation
15-465	Animation Art and Technology
15-466	Computer Game Programming

Human-Computer Interaction

05-410	Introduction to Human-Computer Interaction Methods
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Additionally, students who are interested in Human-Computer Interaction are encouraged to look at the description of the Double Major in Human-Computer Interaction on page 97 of the Undergraduate Catalog.

Language Technologies

11-741	Information Retrieval
11-751	Speech Recognition
15-482	Human Language Technologies
80-180	The Nature of Language

Additionally, students interested in Language Technologies are encouraged to look at the description of the Minor in Language Technologies on page 321 and the Minor in Linguistics on page 222 of the Undergraduate Catalog.

Robotics

16-311	Introduction to Robotics
16-362	Mobile Robot Programming Laboratory
16-363	Advanced Mobile Robot Programming

Additionally, students who are interested in Robotics are encouraged to look at the description of the Minor in Robotics on page 104 of the Undergraduate Catalog.

Scientific Computation

21-259	Calculus in Three Dimensions
21-260	Differential Equations
21-320	Symbolic Programming Methods
21-369	Numerical Methods
36-410	Introduction to Probability Modeling

Additionally, students who are interested in Scientific Computation are encouraged to look at the description of the Minor in Scientific Computing on page 288 in the Undergraduate Catalog as well as the following discipline-specific Computational Science courses:

03-310	Introduction to Computational Biology
09-560	Molecular Modeling and Computational Chemistry
33-241	Introduction to Computational Physics

Software Systems

15-312	Foundations of Programming Languages
15-410	Operating System Design and Implementation
15-411	Compiler Design
15-415	Database Applications
15-441	Computer Networks

Theory

15-312	Foundations of Programming Languages
15-453	Formal Languages and Automata
15-85x	Graduate Theory course
21-301	Combinatorial Analysis
21-341	Linear Algebra
21-355	Principles of Real Analysis I
21-373	Algebraic Structures
21-484	Applied Graph Theory
21-600	Mathematical Logic I

Graduate School Preparation

Students considering going on to graduate school in Computer Science should take a wide variety of Computer Science and Mathematics courses, as well as consider getting involved in independent research. Additionally, graduate CS courses can be taken with permission of the instructor.

Senior Research Thesis

The goal of the Senior Research Thesis Program is to introduce students to the breadth of tasks involved in independent research, including library work, problem formulation, experimentation, and writing and speaking. In particular, students present a brief midterm progress report each semester, present a public poster session in December, present an oral summary in the year-end university-wide Undergraduate Research Symposium and submit a written thesis in May. Students work closely with faculty advisors to plan and carry out their projects. Projects span the entire senior year, and students receive 18 units of academic credit each semester. Nine of these 18 can be counted toward CS elective requirements, and nine as free elective credits; hence, for most students, the thesis program replaces two courses per semester.

Computer Science as a Secondary Concentration

The School of Computer Science offers a Double Major in Computer Science and Minors in Computer Science, Language Technologies, and Robotics. It also jointly offers a Double Major in Human-Computer Interaction.

Double Major in Computer Science

The following courses are required for the Double Major in Computer Science:

Prerequisites:

15-111	Intermediate/Advanced Programming (students with no prior programming experience take 15-100 & 15-111)
15-123	Effective Programming in C and UNIX
21-120	Differential & Integral Calculus
21-122	Integration, Differential Equations, and Approximation
21-127	Concepts of Mathematics
21-241	Matrix Algebra (or 21-341, Linear Algebra)

Double Major requirements:

15-211	Fundamental Data Structures and Algorithms
15-212	Principles of Programming
15-213	Introduction to Computer Systems
15-251	Great Theoretical Ideas in Computer Science
15-451	Algorithm Design and Analysis

One Communications course:

15-221	Technical Communication for Computer Scientists
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One Applications elective:

15-323	Music Systems and Information Processing
15-381	Artificial Intelligence: Representation and Problem Solving
15-384	Robotic Manipulation
15-385	Computer Vision
15-413	Software Engineering
15-415	Database Applications
15-421	Web Commerce, Security and Privacy
15-437	Web Application Development
15-462	Computer Graphics
15-463	Computational Photography
15-482	Human Language Technologies
15-490	Computational Neuroscience
10-601	Machine Learning
16-362	Mobile Robot Programming Laboratory

One Programming elective:

15-312	Foundations of Programming Languages
15-317	Constructive Logic
17-651	Models of Software Systems
21-300	Basic Logic
80-311	Computability and Incompleteness

One Systems elective:

15-410	Operating System Design and Implementation
15-418	Parallel Computer Architecture and Programming
15-441	Computer Networks
18-447	Introduction to Computer Architecture

One Theory elective:

15-354	Computational Discrete Mathematics
15-355	Modern Computer Algebra
15-414	Bug Catching: Automated Program Verification and Testing
15-453	Formal Languages and Automata
21-301	Combinatorics
21-484	Graph Theory

Two Computer Science electives

One of the following Probability courses:

15-359	Probability and Computing
21-325	Probability
36-217	Probability Theory and Random Processes
36-225	Introduction to Probability and Statistics I
36-625	Probability and Mathematical Statistics I

Minor in Computer Science

The following courses are required for the Minor in Computer Science:

Prerequisites:

15-111	Intermediate/Advanced Programming (students with no prior programming experience take 15-100 & 15-111)
21-127	Concepts of Mathematics

Minor requirements:

15-211	Fundamental Data Structures and Algorithms
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One of the following courses:

15-213	Introduction to Computer Systems (requires 15-123 as a prerequisite)
15-251	Great Theoretical Ideas in Computer Science

Three Computer Science electives

Double-Counting Restriction

In order to avoid excessive double-counting, students pursuing a Double Major or Minor in Computer Science must complete at least 6 courses in their home department, of at least 9 units each, none of which are required by (or are cognates for requirements in) the Computer Science major.

Language Technologies Minor

The following courses are required for the Minor in Language Technologies:

Prerequisites:

15-111	Intermediate/Advanced Programming (students with no prior programming experience take 15-100 & 15-111)
21-127	Concepts of Mathematics
15-211	Fundamental Data Structures and Algorithms
15-212	Principles of Programming
15-251	Great Theoretical Ideas in Computer Science

Minor requirements:

Both of the following courses:

15-482	Human Language Technologies
11-721	Grammars and Lexicons

Two of the following electives:

11-411	Natural Language Processing
11-617	LT in CALL
11-711	Algorithms for NLP
11-731	Machine Translation
11-741	Information Retrieval
11-751	Speech Recognition

11-752	Speech II
11-761	Language and Statistics
15-492	Speech Processing
15-493	Information Retrieval
80-180	The Nature of Language
80-280	Linguistic Analysis

A semester-long directed research project

More information on the required research project, and on the minor, can be found at http://www.lti.cs.cmu.edu/lti_minor.

Double-Counting Restriction

CS majors may use 15-482 as an elective for their CS major and also as a required course for the Language Technologies Minor. Courses in the Language Technologies Minor may not also be counted towards another SCS minor.

Robotics Minor

The following courses are required for the Minor in Robotics:

Prerequisites:

15-111	Intermediate/Advanced Programming (students with no prior programming experience take 15-100 & 15-111)
15-123	Effective Programming in C and UNIX

Minor requirements:

Both of the following courses:

15-384	Robotic Manipulation
16-311	Introduction to Robotics

One of the following courses:

16-299	Introduction to Feedback Control Systems
18-370	Fundamentals of Control
24-452	Feedback Control Systems

Two of the following electives:

15-381	Artificial Intelligence: Representation & Problem Solving
15-385	Computer Vision
15-462	Computer Graphics
15-463	Computational Photography
15-681	Artificial Intelligence: Machine Learning
16-284	Humanoids
16-362	Mobile Robot Programming Laboratory
16-721	Advanced Perception
16-735	Motion Planning
16-778	Mechatronic Design
60-422	Advanced ETB: Robotic Art Studio
85-213	Information Processing and Artificial Intelligence
85-370	Perception

More information on the minor can be found at http://www.ri.cmu.edu/education/ugrad_minor.html.

Double-Counting Restriction

Courses in the Robotics Minor may not also be counted towards another SCS minor.

Software Engineering Minor

The following courses are required for the Minor in Software Engineering:

Prerequisites

15-211	Fundamental Data Structures and Algorithms, <i>plus one of the following:</i>
15-212	Principles of Programming
15-213	Introduction to Computer Systems

Core Course Requirements

15-313	Foundations of Software Engineering
15-413	Software Engineering Practicum

Electives

1. One domain-independent course focused on technical software engineering material, and

15-414	Bug Catching: Automated Program Verification and Testing
17-606	Software Systems Security Engineering

17-619	Introduction to Real-Time Software and Systems
17-651	Models of Software Systems
17-652	Methods: Deciding What to Design
17-653	Managing Software Development (prerequisite: 15-413 or an internship)

17-654	Analysis of Software Artifacts
17-655	Architectures for Software Systems (prerequisite: 15-413 or an internship)

17-690 Seminar in Software Process

Other courses, with **prior** approval from the Director of the Software Engineering Masters Program.

2. One engineering-focused course with a significant software component, and

15-410	Operating System Design and Implementation
15-412	Operating System Practicum
15-437	Web Application Development
15-441	Computer Networks
15-540	Rapid Prototyping of Computer Systems
17-643	Hardware for Software Engineers
18-549	Embedded Systems Design
18-649	Distributed Embedded Systems
18-749	Fault-Tolerant Distributed Systems (not presently offered)

Other courses, with **prior** approval from the Director of the Software Engineering Masters Program.

3. One course that explores computer science problems related to existing and emerging technologies and their associated social, political, legal, business, and organizational contexts

05-801	Computer-Supported Cooperative Work
08-200	Ethical Dilemmas and Policy Issues in Computing
08-300	Constructing Appropriate Technology
08-531	Usable Privacy and Security
08-532	Law of Computer Technology
08-533	Privacy Policy, Law and Technology
08-781	Mobile and Pervasive Computing Services
08-782	Adaptive Trading Technologies
08-801	Dynamic Organizations and Networks
08-810	Computational Modeling of Complex Socio-Technical Systems
15-390	Entrepreneurship for Computer Science
15-391	Technology Consulting in the Community
15-421	Web Commerce, Security and Privacy
15-502	Technology for Global Development
19-402	Telecommunications, Technology Policy & Management
19-403	Policies of Wireless Systems and the Internet
70-311	Organizational Behavior
70-414	Technology Based Entrepreneurship for CIT
70-421	Entrepreneurship for Computer Scientists
70-459	Web Business Engineering
70-471	Logistics and Supply Chain Management
88-260	Organizations
88-341	Organizational Communication
88-343	Economics of Technological Change
88-393	Technology and Economic Growth

Required Internship and Reflection Course

A software engineering internship of a minimum of 8 full-time weeks in an industrial setting is required. The student must be integrated into a team and exposed to industry pressures. The intern may work in development, management, quality assurance, or other relevant positions. The director of the SE minor program has sole discretion in approving an internship experience based on these criteria. Students should confirm that an internship position is appropriate before accepting it, but internships that fulfill the criteria will also be accepted after the fact.

17-413 Internship Reflection (required 6 unit course, number to be determined, to be offered Fall semester):

Each student will write an issue-focused reflection and analysis of some personal software engineering experience, typically (but not always) based on the engineering internship above. This report must be passed by one SCS faculty member and one SE Ph.D. student, for both technical content and effective written communication. Initial course meetings will cover the reflective, writing, and speaking process. In later meetings, each student will present his or her experience through a 30-45 minute talk, which will be evaluated for communication skills and critical reflective content. This course is limited to enrollment of 16, and students who are admitted to the minor program are given first priority.

Double Counting Rule.

At most 2 of the courses used to fulfill the minor requirements may be counted towards any other major or minor program.

For more information, visit <http://www.cs.cmu.edu/~aldrich/se-minor/>

School of Computer Science (SCS)**Academic Standards and Actions****Grading Practices**

Grades given to record academic performance in SCS are detailed under Grading Practices on page 54 of the Undergraduate Catalog.

Dean's List

SCS recognizes each semester those undergraduates who have earned outstanding academic records by naming them to the Dean's List. The criterion for such recognition is a quality point average of at least 3.75 while completing a minimum of 36 factorable units and earning no incomplete grades.

Academic Actions

In the first year, quality point averages below 1.75 in either semester invoke an academic action. For all subsequent semesters an academic action will be taken if the semester quality point average or the cumulative quality point average (excluding the first year) is below 2.00.

Probation: The action of probation will be taken in the following cases:

1. One semester of the first year is below 1.75 QPA;
2. The semester QPA of a student in good standing beyond the first year falls below 2.00.

The term of probation is one semester as a full-time student. First year students are no longer on probation at the end of the second semester if the second semester's QPA is 1.75 or above. Students in the third or subsequent semester of study are no longer on probation at the end of one semester if the semester QPA and cumulative QPA (excluding the first year) are 2.00 or above.

Probation Continued: A student who has had one semester on probation and is not yet meeting minimum requirements but whose record indicates that the standards are likely to be met at the end of the next semester of study is occasionally continued on probation. This action is normally taken only when a student's semester QPA is above 2.0 but their cumulative QPA is not yet above 2.0.

Suspension: A student who does not meet minimum standards at the end of one semester of probation will be suspended.

- A first year student will be suspended if the QPA from each semester is below 1.75.
- A student on probation in the third or subsequent semester of study will be suspended if the semester QPA is below 2.00.

The minimum period of suspension is one academic year (two semesters). At the end of that period a student may return to school (on probation) by:

1. Receiving permission in writing from the assistant dean for undergraduate education,
2. Completing a Return from Leave form from the Registrar's Office, and
3. Providing transcripts and clearance forms if the student has been in a degree program at another college or university. Academic credit earned in such circumstances will not transfer back to Carnegie Mellon.

Students who have been suspended or have withdrawn are required to absent themselves from the campus (including residence halls and Greek houses) within a maximum of two days after the action and to remain off the campus for the duration of the time specified. This action includes debarment from part-time or summer courses at the university for the duration of the period of the action.

Although suspended students may not hold student jobs, students on academic suspension may, under certain circumstances, have a non-student job with the university. Students on disciplinary or administrative suspension may not.

Drop: This is a permanent severance. A student who has been suspended and who fails to meet minimum standards after returning to school is dropped.

Students who have been dropped are required to absent themselves from the campus (including residence halls and Greek houses) within a maximum of two days after the action.

The relation indicated above between probation, suspension and drop is normal, not binding. In unusual circumstances, the College Council may suspend or drop a student without prior probation.

Transfer into SCS

Undergraduate students admitted to colleges at CMU other than SCS and wishing to transfer into SCS during their first year should consult with the Assistant Dean for Undergraduate Education. In general, no undergraduate student will be considered for transfer until after having completed 15-211, Fundamental Data Structures and Algorithms. At that time, the decision to allow transfer will be made based on availability of space in the student's class and the student's academic performance.

Procedure for transfer of students from another university into SCS: A student first applies through the Office of Admission. If the Office of Admission believes the applicant is acceptable, the student's record is sent to SCS for evaluation. Extremely few external transfers are admitted.

Graduation Requirements

1. A requirement for graduation is the completion of the program specified for a degree with a cumulative quality point average of 2.00 or higher for all courses taken after the first year.
2. Students must be recommended for a degree by the faculty of SCS.
3. A candidate for the bachelor's degree must complete at the University a minimum of four semesters of full-time study, or the equivalent of part-time study, comprising at least 180 units of course work.
4. Students will be required to have met all financial obligations to the university before being awarded a degree.

Modification of Graduation Requirements: A student may seek permission to modify graduation requirements by petition to the SCS College Council.

Research and Teaching Faculty

VICTOR ADAMCHIK, Associate Teaching Professor — Ph.D., Byelorussian State University; Carnegie Mellon, 2000—.

JONATHAN ALDRICH, Assistant Professor — Ph.D., University Of Washington; Carnegie Mellon, 2003—.

VINCENT ALEVEN, Assistant Professor — Ph.D., University Of Pittsburgh; Carnegie Mellon, 1997—.

OMEAD AMIDI, Senior Systems Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1994—.

DAVID ANDERSEN, Assistant Professor — Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 2005—.

JOHN ANDERSON, Walter Vandyke Bingham Professor — Ph.D., Stanford University; Carnegie Mellon, 1978—.

DIMITRIOS APOSTOLOPOULOS, Senior Systems Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1989—.

CHRISTOPHER ATKESON, Professor — Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 2000—.

JAMES BAGNELL, Research Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2004—.

JOHN BARES, Research Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1993—.

ZIV BAR-JOSEPH, Assistant Professor — Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 2003—.

JOSEPH BECK, Systems Scientist — Ph.D., University Of Massachusetts; Carnegie Mellon, 2003—.

DARRIN BENTIVEGNA, Systems Scientist — Ph.D., Georgia Institute of Technology; Carnegie Mellon, 2005—.

MARCEL BERGERMAN, Systems Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2005—.

HANS BERLINER, Research Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1969—.

ALAN BLACK, Associate Professor — Ph.D., University Of Edinburgh; Carnegie Mellon, 1999—.

GUY BLELLOCH, Professor — Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 1988—.

AVRIM BLUM, Professor — Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 1991—.

LENORE BLUM, Distinguished Career Professor — Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 1999—.

MANUEL BLUM, Professor — Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 1999—.

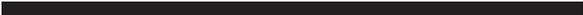
- DAVID BOURNE, Principal Systems Scientist — M.S., University Of Pennsylvania; Carnegie Mellon, 1980—.
- DANIEL BOYARSKI, Professor and Head, School of Design — M.F.A., Indiana University; Carnegie Mellon, 1982—.
- STEPHEN BROOKES, Professor — Ph.D., University College; Carnegie Mellon, 1981—.
- RALF BROWN, Senior Systems Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1993—.
- BRETT BROWNING, Systems Scientist — Ph.D., University of Queensland; Carnegie Mellon, 2000—.
- RANDAL BRYANT, University Professor and Dean, School of Computer Science — Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 1984—.
- JAMES CALLAN, Professor — Ph.D., University Of Massachusetts; Carnegie Mellon, 1999—.
- JAIME CARBONELL, Allen Newell Professor, Director, Language Technologies Institute — Ph.D., Yale University; Carnegie Mellon, 1979—.
- KATHLEEN CARLEY, Professor — Ph.D., Harvard University; Carnegie Mellon, 2002—.
- JACOBO CARRASQUEL, Associate Teaching Professor — M.S., Carnegie Mellon University; Carnegie Mellon, 1984—.
- HOWARD CHOSET, Associate Professor — Ph.D., California Institute Of Technology; Carnegie Mellon, 1996—.
- MICHAEL CHRISTEL, Senior Systems Scientist — Ph.D., Georgia Institute Of Technology; Carnegie Mellon, 1987—.
- EDMUND CLARKE, Fore Systems Professor Of Computer Science — Ph.D., Cornell University; Carnegie Mellon, 1982—.
- WILLIAM COHEN, Associate Research Professor — Ph.D., Rutgers University; Carnegie Mellon, 2003—.
- ERIC COOPER, Distinguished Service Professor — Ph.D., University Of California At Berkeley; Carnegie Mellon, 1985—.
- SETH COPEN GOLDSTEIN, Associate Professor — Ph.D., University Of California; Carnegie Mellon, 1997—.
- ALBERT CORBETT, Associate Research Professor — Ph.D., University Of Oregon; Carnegie Mellon, 1983—.
- THOMAS CORTINA, Lecturer — Ph.D., Polytechnic University; Carnegie Mellon, 2004—.
- CHARLES CRANOR, Systems Scientist — Ph.D., Washington University; Carnegie Mellon, 2003—.
- LORRIE CRANOR, Associate Professor — Ph.D., Washington University; Carnegie Mellon, 2003—.
- KARL CRARY, Associate Professor — Ph.D., Cornell University; Carnegie Mellon, 1998—.
- WANDA DANN, Associate Teaching Professor — Ph.D., Syracuse University; Carnegie Mellon, 2008—.
- ROGER DANNENBERG, Associate Research Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1982—.
- FERNANDO DE LA TORRE FRADE, Research Scientist — Ph.D., La Salle School of Engineering; Carnegie Mellon, 2002—.
- MARK DERTHICK, Research Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1995—.
- ANIND DEY, Assistant Professor — Ph.D., Georgia Institute Of Technology; Carnegie Mellon, 2005—.
- M BERNARDINE DIAS, Research Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2003—.
- ANTHONY DIGIOIA, Associate Research Professor — M.D., Harvard Medical School; Carnegie Mellon, 1999—.
- JOHN DOLAN, Senior Systems Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1991—.
- ARTUR DUBRAWSKI, Systems Scientist — Ph.D., Institute of Fundamental Technological Research; Carnegie Mellon, 1995—.
- DAVID ECKHARDT, Associate Teaching Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2003—.
- WILLIAM EDDY, Professor — Ph.D., Yale University; Carnegie Mellon, 1976—.
- ALEXEI EFROS, Assistant Professor — Ph.D., University Of California At Berkeley; Carnegie Mellon, 2004—.
- JEFFREY EPPINGER, Professor Of The Practice — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2001—.
- MICHAEL ERDMANN, Professor — Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 1989—.
- MAXINE ESKENAZI, Associate Teaching Professor — Ph.D., University Of Paris; Carnegie Mellon, 1994—.
- SCOTT FAHLMAN, Research Professor — Ph.D., Massachusetts Institute Of Technology; Carnegie Mellon, 1978—.
- CHRISTOS FALOUTSOS, Professor — Ph.D., University Of Toronto; Carnegie Mellon, 1997—.
- DAVID FARBER, Distinguished Career Professor — M.S., Stevens Institute Of Technology; Carnegie Mellon, 2002—.
- GARY FEDDER, Professor — Ph.D., University Of California At Berkeley; Carnegie Mellon, 1994—.
- DAVID FEINBERG, Lecturer — M. Eng., Massachusetts Institute Of Technology; Carnegie Mellon, 2008—.
- STEPHEN FIENBERG, Maurice Falk University Professor — Ph.D., Harvard University; Carnegie Mellon, 1980—.
- EUGENE FINK, Senior Systems Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2003—.
- JODI FORLIZZI, Associate Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2000—.
- ROBERT FREDERKING, Senior Systems Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1991—.
- DAVID GARLAN, Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1990—.
- ANATOLE GERSHMAN, Research Professor — Ph.D., Yale University; Carnegie Mellon, 2007—.
- ZOUBIN GHAHRAMANI, Associate Research Professor — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2002—.
- GARTH GIBSON, Professor — Ph.D., University Of California; Carnegie Mellon, 1991—.
- CLARK GLYMOUR, Alumni University Professor — Ph.D., Indiana University; Carnegie Mellon, 1985—.
- GEOFFREY GORDON, Associate Research Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2001—.
- REID GORDON SIMMONS, Research Professor — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1988—.
- CARLOS GUESTRIN, Assistant Professor — Ph.D., Stanford University; Carnegie Mellon, 2004—.
- ANANDA GUNAWARDENA, Associate Teaching Professor — Ph.D., Ohio University; Carnegie Mellon, 1998—.
- ANUPAM GUPTA, Assistant Professor — Ph.D., University Of California At Berkeley; Carnegie Mellon, 2002—.
- MOR HARCHOL-BALTER, Associate Professor — Ph.D., University Of California; Carnegie Mellon, 1999—.
- ROBERT HARPER, Professor — Ph.D., Cornell University; Carnegie Mellon, 1988—.
- ALEXANDER HAUPTMANN, Senior Systems Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1994—.
- MARTIAL HEBERT, Professor — Ph.D., Paris-XI; Carnegie Mellon, 1984—.
- WILLIAM E HEFLEY, Associate Teaching Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2002—.
- JAMES HERBSLEB, Professor — Ph.D., University Of Nebraska; Carnegie Mellon, 2002—.
- ALEX HILLS, Distinguished Service Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1992—.
- JESSICA HODGINS, Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2000—.
- TIMOTHY HOFFMAN, Lecturer — M.S., University Of Pittsburgh; Carnegie Mellon, 2000—.
- RALPH HOLLIS, Research Professor — Ph.D., University Of Colorado; Carnegie Mellon, 1993—.
- JASON HONG, Assistant Professor — Ph.D., University Of California At Berkeley; Carnegie Mellon, 2004—.
- DANIEL HUBER, Systems Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2002—.

- SCOTT HUDSON, Professor — Ph.D., University Of Colorado; Carnegie Mellon, 1997—.
- DOUG JAMES, Assistant Professor — Ph.D., University Of British Columbia; Carnegie Mellon, 2002—.
- BRANISLAV JARAMAZ, Associate Research Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1997—.
- BONNIE JOHN, Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1989—.
- ANGEL JORDAN, Keithley University Professor Emeritus — Ph.D., Stanford University; Carnegie Mellon, 1985—.
- MATTHEW KAM, Assistant Professor — Ph.D., University Of California At Berkeley; Carnegie Mellon, 2008—.
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Tepper School of Business

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The undergraduate and masters students gain a solid foundation in the fundamental scientific disciplines of economics, the behavioral sciences, and the management sciences. The program emphasizes the functional areas of accounting, information systems, finance, marketing, production management, and human resources management. In addition, students attain analytical problem-solving skills, computing skills, and written and oral communication skills. The curriculum culminates in the application of knowledge to real-world problems, so that students can integrate and apply what they have learned.

At the Tepper School, research and education are closely related. Our outstanding faculty develops new ideas and brings results of its research to the students, demonstrating the importance of critical thinking and of a continuing search for excellence. The faculty is particularly renowned for cutting-edge work in operations research, economics, management information systems, finance, accounting, marketing, and operations management/production. Among our faculty legacy are 6 Nobel laureates, a Nobel record that is unsurpassed by any business school worldwide. The Tepper School alumni have a remarkable track record of success and leadership in careers spanning global industries such as finance, strategy, marketing, and general management. They are represented internationally in the ranks of the Fortune 500 companies, as heads of dynamic entrepreneurial ventures, and as leading faculty members in America's top academic institutions. Moreover, they provide a strong network for new graduates.

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Part-Time Faculty

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RICHARD L. BRYANT, Adjunct Professor of Business — MBA, Carnegie Mellon University; Carnegie Mellon, 1999—.

BABS BAILEY CARRYER, Adjunct Professor of Entrepreneurship — MPM, Carnegie Mellon; Carnegie Mellon, 1998—.

LLOYD CORDER, Adjunct Professor of Marketing — Ph.D., University of Pittsburgh; Carnegie Mellon, 2000—.

ROBERT F. CULBERTSON III, Adjunct Professor of Entrepreneurship — MSIA and MS Engineering, Carnegie Mellon; Carnegie Mellon, 1999—.

L. FRANK DEMMLER, Adjunct Professor of Entrepreneurship —MBA, University of California at Los Angeles; Carnegie Mellon, 2002—.

ROB DILLON, Adjunct Professor of Graphic Communications — B.A., University of Pittsburgh; Carnegie Mellon, 2001—.

JUAN DUBRA, Visiting Associate Professor of Economics — Ph.D., New York University; Carnegie Mellon (Springs Only), 2006—.

CLIFFORD T. EARLY, Adjunct Professor of Law — J.D. University of Pittsburgh; Carnegie Mellon, 2000—.

THOMAS F. FAUGHT, JR., Adjunct Professor of Business Strategy — MBA, Harvard Business School; Carnegie Mellon, 2001—.

CAROL GOLDBURG, Adjunct Professor of Economics and Director, Undergraduate Economics Program — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2005—.

GEOFFREY HITCH, Adjunct Professor of Acting — B.F.A., Carnegie Mellon University; Carnegie Mellon, 1992—.

JOSEPH S. HORNACK, Adjunct Professor of Law — J.D., Rutgers, The State University of New Jersey; Carnegie Mellon, 1990—.

ROBERT E. KELLEY, Adjunct Professor of Organizational Behavior and Theory — Ph.D. Columbia University; Carnegie Mellon, 1981—.

JOHN LANKFORD, Adjunct Professor of Marketing — MBA, The University of Michigan; Carnegie Mellon, 1998—.

PETER ORESICK, Adjunct Professor of Graphic Communication — MFS in Writing, University of Pittsburgh; Carnegie Mellon, 2001—.

DAVID RAMIREZ, Adjunct Professor of Business — MBA, Carnegie Mellon University; Carnegie Mellon, 2007—.

NORMAN ROBERTSON, Adjunct Professor of Economics — B.Sc., University of London; Carnegie Mellon, 1985—.

PETER J. ROMAN, Adjunct Professor of Marketing — BSBA, Providence College; Carnegie Mellon, 2002—.

FREDERICK H. RUETER, Adjunct Professor of Economics — Ph.D., Carnegie Mellon; Carnegie Mellon, 1988—.

PATRICK W. SILEO, Adjunct Professor of Economics — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2000—.

RICHARD P. SIMMONS, Distinguished Adjunct Professor of Business Management — B.S., Massachusetts Institute of Technology; Carnegie Mellon, 2002—.

JOEL STERN, Distinguished Adjunct Professor of Finance — MBA, University of Chicago; Carnegie Mellon, 1996—.

Undergraduate Business Administration Program

Milton L. Cofield, Ph.D., Executive Director

The Tepper School program in undergraduate business education is intended for students interested in an undergraduate management educational experience that is broad and based upon the liberal arts, quantitative studies and analytical reasoning as its foundation. Such a program is both intellectually strong and flexible enough to accommodate the interests of students with diverse, ranging from beginning a career to graduate study.

The curriculum is designed around a central core of courses in the liberal arts, the functional areas of business, economics, mathematics and computing course requirements. To this is added a requirement for in-depth study in one of the core functional business areas such as finance, information systems, marketing, entrepreneurship or manufacturing management. Finally, the curriculum requires all students to have a minor in the curricula of another college in order to obtain the additional breadth and flexibility that promotes confidence in one's knowledge and its benefits for a lifetime. We believe this curriculum structure is that needed for those who will be leaders in the globalizing business and political environment in which organizations of the future will pursue their goals.

Our curriculum prepares students to begin their professional careers in all areas of management and they do so in some of the world's leading service, manufacturing, and governmental organizations. Many go on to graduate study in law, economics, finance and policy studies at the leading universities in the world.

In addition to the major in business administration, we offer the opportunity for a minor or second major to students in other programs of the university. If you are seriously interested in management education in an environment that offers the best undergraduate experience, please contact the undergraduate business advisor in the Tepper School of Business.

Business Administration Major Requirements

To receive a degree in Business Administration, students must complete at least 364 units, consisting of three basic core sequences, as well as breadth, track and minor requirements.

These requirements break down as follows:

Functional Business Core	Units
70-100 Introduction to Business	9
70-122 Introduction to Accounting	9
70-201 Professional and Service Projects	9
70-311 Organizational Behavior	9
70-332 Business, Society and Ethics	9
70-340 Business Communications	9
70-345 Business Presentations	9
70-371 Production/Operations Management	9
70-381 Marketing	9
70-391 Finance	9
70-401 Management Game	12
70-451 Management Information Systems	9
Total:	111

Economics Core	Units
73-100 Principles of Economics	9
73-150 Microeconomics	9
73-200 Macroeconomics	9
Total:	27

Mathematics/Computing Core Units	Units
15-100 Intro/Inter Programming	10
21-120 Differential and Integral Calculus	10
21-256 ¹ Multivariate Analysis and Approximation	9
21-257 ² Models and Methods of Optimization	9
70-207 Probability and Statistics	9
70-208 Regression Analysis	9
99-101/102 Computing @ Carnegie Mellon	3
Total:	59

¹ or 21-259 Calculus in 3D

² or 21-292 Operations Research

Breadth Requirements 63 Units

For a list of courses in each category, please see the Undergraduate Business Administration website: www.tepper.cmu.edu.

Required:

76-101 Interpretation and Argument
79-104 Introduction to World History

Science & Technology
Cognition, Choice & Behavior
Political & Social Institutions
Creative Production & Reflection
Cultural Analysis

A TOTAL OF SEVEN BREADTH COURSES IS REQUIRED.

Track Requirements 54 Units

A BA Track consists of a menu of courses (both required and elective) that the student must complete in order to obtain in-depth knowledge of a particular functional area of management expertise.

Tracks:

Computing and Information Technology
Entrepreneurship
Finance
General Management
Graphic Media Management
International Management
Manufacturing Management and Consulting
Marketing

Minor Requirement 54 Units

Students are required to complete a minor in another department. Students may select any minor offered at Carnegie Mellon to fulfill this requirement. Minors that blend well with the business curriculum include: Psychology, Statistics, Economics, Communication Design, and Political Science. Students should consult the catalog regarding the specific requirements of any minor and should meet with their advisor to discuss their choice.

Suggested Course Plan

What follows is a suggested course plan for BA students. Be careful to observe any pre- and co-requisite requirements for each course. These are given in the course descriptions found at the back of this catalog.

First Year		Units
	Fall	
21-120	Differential and Integral Calculus	10
70-100	Introduction to Business	9
73-100	Principles of Economics	9
76-101	Interpretation and Argument ³	9
xx-xxx	Breadth course	9
99-101/102	Computing @ Carnegie Mellon	3
		49
	Spring	
21-256	Multivariate Analysis and Approximation	9
73-150	Microeconomics	9
15-100	Intro/Inter Programming	10
79-104	Introduction to World History	9
xx-xxx	Breadth course	9
		46

³ 76-101 and 79-104 can switch semesters, but cannot be taken together.

Sophomore Year

	Units
21-257 ⁴ Models and Methods of Optimization ⁷	9
70-122 Introduction to Accounting	9
70-207 Probability and Statistics	9
73-200 Macroeconomics	9
xx-xxx Breadth course	9

45

Spring

70-208 Regression Analysis	9
70-311 Organizational Behavior	9
70-340 Business Communication	9
xx-xxx Minor Course	9
xx-xxx Breadth course	9

45

⁴ or 21-292 Operations Research, offered in spring semesters only

Junior Year

	Units
70-371 Production and Operations Management	9
70-381 Marketing	9
70-391 Finance	9
70-451 Management Information Systems	9
xx-xxx Breadth Course	9

45

Spring

70-332 Business, Society and Ethics	9
70-345 Business Presentations	9
70-451 Minor Course	9
70-xxx Track Course	9
70-xxx Track Course	9

45

Senior Year

	Units
70-xxx Track Course	9
70-xxx Track Course	9
xx-xxx Minor Course	9
xx-xxx Minor Course	9
70-201 Service Project	9

45

Spring

70-401 Management Game	12
70-xxx Track Course	9
70-xxx Track Course	9
xx-xxx Minor Course	9
xx-xxx Minor Course	9

45

Total units required: 364

Bachelor of Science in Computational Finance

The Bachelor of Science in Computational Finance is an Intercollege Program. Students who pursue Computational Finance as their primary major may elect to have either the Mellon College of Science (MCS) or the Tepper School of Business (Tepper) as their home college. The coursework required for the major is the same in either case, with the exception of the breadth component requirement and those of the functional business core.

Tepper Students must complete the breadth requirements of the undergraduate business administration program. Additionally, they must complete the Functional Business Core. The complete sequence of courses for this major may be found in the Intercollege Programs section of the catalog.

Students who are thinking of the BSCF major should meet with an academic advisor in the Tepper School as soon as their interest is firm in order to make sure they are completing the correct sequence of courses.

Additional Major Requirements

Students may apply to be admitted to the study of an additional major in business administration in their junior year. Applications will be accepted two weeks prior to Spring & Fall Registration week.

The decision to accept a student into the additional major will be based upon a variety of factors including:

- An overall GPA of 3.25 or greater;
- Having completed or being currently enrolled in all of the mathematics & statistics, economics, and computing requirements of the business administration degree prior to submitting an application for admission to the additional major;
- The extent of completion of the business administration functional core course requirements;
- The availability of admission enrollment spaces in the graduating class year for which the student is applying.

Acceptance in the additional major is subject to the University policy which states that the ability to satisfy the requirements for an additional major cannot be guaranteed for any student and will be based upon course availability and the time the student is willing to invest to satisfy all of the requirements of the additional major. In some cases this might require more than 8 semesters of undergraduate study.

The student seeking an additional major in business administration is required to complete all of the requirements listed below without substitution:

Course Requirements**Mathematics and Statistics**

21-120	Calculus (or 21-111 and 21-112)
21-256	Multivariate Analysis and Approximation (or 21-259)
21-257	Models and Methods of Optimization (or 21-292 Operations Research)
70-207	Probability and Statistics (or 36-201 Statistical Reasoning)
70-208	Regression Analysis (or 73-226 Quantitative Economic Analysis)

Computing

99-101/102	Computing @ Carnegie Mellon
15-100/102	Programming Course

Economics

73-100	Principles of Economics
73-150	Microeconomics
73-200	Macroeconomics

Business

70-122	Introduction to Accounting
70-311	Organizational Behavior
70-332	Business, Society and Ethics
70-345	Business Presentations
70-371	Production/Operations Management
70-381	Marketing
70-391	Finance
70-451	Management Information Systems ⁵
70-401	Management Game ⁶
70-3xx/4xx	Electives (2)

⁵ Students in IS and CS must select a 70-4xx course from the Computing and Information Technology Track.

⁶ Students seeking an additional major in BA may not substitute 70-440 for 70-401.

Minor in Business Administration

The minor in business administration requires a total of 6 courses or 54 units of which two courses must be 70-381 Marketing and 73-100 Principles of Economics. The remaining 4 courses can be chosen from any offered in the department. Some of the most common choices that have been made are from the following list:

(A Total of 54 units or 6 courses):

70-381	Marketing
73-100	Principles of Economics
70-122	Introduction to Accounting
70-311	Organizational Behavior
70-371	Production/Operations Management
70-391	Finance
70-342	Managing Across Cultures
70-430	International Management
70-436	Corporate Social Responsibility
70-451	Management Information Systems ⁷
70-480	International Marketing
70-481	Market Research
70-483	Advertising and Marketing Communications
70-484	Direct Marketing

⁷ Students in IS and CS cannot take 70-451; they may select another 70-4xx course from the Computing and Information Technology track.

Some courses have prerequisites that might include specific mathematics or other BA courses. These may be found in the course descriptions and should be discussed with an advisor.

Students may declare the minor at any point after their freshman year by completing the minor declaration form. The form is available online at the Undergraduate Business Administration Website.

Minor in Supply Chain Management

(CIT Students Only)

The minor in Supply Chain Management is open only to students in the Carnegie Institute of Technology. The minor consists of business courses that are oriented towards problems encountered in the manufacturing and operations environments in which many engineering students begin their careers. It is especially well-suited for engineering students for these reasons. Given the increased interest by many companies in optimization, logistics, supply chain management and their effect on enhancing efficiency and reducing costs, this minor is particularly valuable to engineering majors.

Required:

70-371	Production/Operations Management
70-471	Logistics and Supply Chain Management
21-257	Models and Methods for Optimization, or
21-292	Operations Research I
70-460	Mathematical Models for Consulting, or
70-474	Quality Principles and Techniques

Business Administration Policies

Transfer Students

The undergraduate business administration program does not accept students for transfer admission from any academic institution outside of Carnegie Mellon University.

Current Carnegie Mellon University students who are in other colleges may seek to transfer into the undergraduate business administration program on a limited basis. Freshman students will not be considered for transfer until the spring term mid-semester grades for their first year of study have been posted.

All other students may apply for transfer by completing the transfer application that is found online in the undergraduate business program pages of the Tepper School website. Students may apply for transfer two times in each academic year at the mid-semester of the Fall and Spring terms. Successful transfer is limited by both space and academic performance criteria. Students may be denied transfer if their academic performance prior to seeking transfer indicates that they will be unable to complete degree requirements in a timely way or if they have serious academic performance deficiencies. No students whose academic performance would merit an academic action in the Tepper School will be permitted to transfer into the undergraduate business program.

Transfer of Course Credit

Students may receive credit for a maximum of three courses (27 units) of course work taken at other institutions and only provided they have received prior approval to take these courses for degree credit. Students seeking an additional major may only receive credit for a maximum of two courses (18 units) and those completing a minor may only receive credit for one course (9 units) through transferred credit. No transferred credit will be awarded for any course in which the grade received is less than a B. Transferred courses count only for credit and no grade from a transferred course will count toward the student's overall QPA.

Students receiving 36 units or more of AP/IB/Cambridge credit towards their degree requirements will not be eligible to transfer any additional coursework unless it is for an approved study abroad experience. Credit for college courses taken prior to enrolling at Carnegie Mellon will be at the discretion of the department.

No courses taken online will be accepted for transfer credit.

Pass/Fail

Students may use a maximum of 9 units Pass/Fail credit towards their graduation requirement.

Academic Advising

Students are required to meet with a Business Administration advisor at least once each semester to ensure that they are making normal progress towards their degree. An appointment for advising may be scheduled at any time by sending a request to uba@andrew.cmu.edu.

Dean's List

Students who receive a semester QPA of 3.50 or higher (with at least 45 factorable units and receiving no incompletes) will be placed on the Dean's List for that semester.

The College Honors Program

Students with outstanding records (minimum QPA of 3.75) and with at least 270 units of credit are invited to undertake an honor's thesis project under the direction of a faculty member for 18 units of credit. Students meeting these criteria are highly encouraged to consider the honor's thesis option. For more information about the honor's thesis, please see the course description for 70-500 or contact an advisor.

Graduation Requirements

In order to graduate with the Bachelor of Science in Business Administration, students must meet all requirements specified for the program with a cumulative QPA of at least 2.00.

Students must also meet all university residence requirements and all financial obligations to the university before being awarded a degree. It is the student's responsibility to make certain they meet all of the requirements for graduation by consulting with our advising staff on a regular basis.

Undergraduate Economics Program

Dennis Epple, Head of Economics
 Carol B. Goldberg, Director of Undergraduate Economics
<http://www.tepper.cmu.edu/economics>
 E-mail: econprog@andrew.cmu.edu

At its most fundamental level, economics is the study of how scarce resources are allocated. What will be produced and consumed, how much, and by whom? These questions, central to the well-being of people throughout the world, are the focus of economics. Economists identify, model, and analyze problems, developing meaningful solutions for the challenges confronting society. Economists are also active participants in the processes and institutions through which the pressing concerns of society are addressed. Economists help businesses, political bodies, and other organizations make better decisions through the development of market strategies, the promulgation of regulatory structures, and the formulation of appropriate government policies. Increasingly, economists are taking advantage of new technologies to design and implement new markets and exchange mechanisms.

Carnegie Mellon University enjoys a rich history of innovative research in the field of Economics. By bringing together rigorous theoretical and empirical work, the University supports some of the very best research. Six of our past and present faculty have been awarded the Nobel Prize in Economics. In the classroom, we bring the same rigorous, innovative approach to enable our students to develop their talents and realize the potential of their tremendous analytical skills.

At Carnegie Mellon University, the Undergraduate Economics Program is supported by both the Tepper School of Business and the College of Humanities and Social Sciences. Economics majors are considered members of both colleges and enjoy their full support and services.

Degree Options

In order to accommodate students' wide variety of goals, three primary degree programs are available: Bachelor of Arts in Economics, Bachelor of Science in Economics, and Bachelor of Science in Economics and Statistics (jointly administered by the Department of Statistics and the Undergraduate Economics Program).

For students who major in other academic fields, an additional major program and a minor degree program in Economics are available. This information can be found following the discussions about the major curricula and schedules.

The three degree programs have been designed to provide students with a solid understanding of the central theories and analytical tools of the field of economics, while maintaining the flexibility necessary to meet the needs of a diversity of career paths. The three degrees produce strong analytical thinkers who are able to model and analyze complex problems. Graduates of the Undergraduate Economics Program gain employment as economic analysts in both the private and public sectors; pursue advanced professional degrees in business, law, and public policy; as well as enter into Ph.D. programs in economics, statistics, finance, and related fields.

First-year students are not expected to know which degree option they wish to pursue. For this reason, the first-year curricula are identical. As students become involved in their course work, participate in the extra- and co-curricular activities sponsored by the Undergraduate Economics Program, and talk with an economics advisor, the decision of which degree to pursue becomes quite evident.

The B.A. in Economics Curriculum and The B.S. in Economics Curriculum are designed to provide students with a solid understanding of the economic theory and quantitative economic analysis. The introductory core disciplinary sequences in economic theory and quantitative analysis are identical: both rely on the same knowledge base of calculus and statistics. Where these two degree programs differ is in their emphases of study in the advanced levels. The advanced data analysis component of the **B.A. in Economics Curriculum** pays additional attention to ordinal data and the study of surveys. The flexibility of the "Special Electives" requirement allows students the opportunity to study political, historical, cultural, and social institutions. In the advanced levels

of the economic theory component of the **B.S. in Economics Curriculum**, the foundations of modern economics are examined, using mathematically sophisticated models. The capstone of this degree program is the Senior Project course where students use their qualitative and quantitative skills to contribute to the body of knowledge in empirical, experimental, and/or theoretical studies.

The B.S. in Economics and Statistics Curriculum is a collaborative effort between the Department of Statistics and the Undergraduate Economics Program. It provides an interdisciplinary course of study aimed at students with a strong interest in the empirical analysis of economic data. The major's curriculum provides students with a solid foundation in the theories and methods of both fields. Students in this major are trained to advance the understanding of economics issues through the analysis, synthesis, and reporting of data using the advanced empirical research methods of statistics and econometrics.

Dual Degree in Economics

A student pursuing a primary degree outside of the department may obtain a dual degree in economics by completing all of the requirements for a B.S. in Economics. In addition, the student's total units complete must be at least 90 units in excess of the requirement for the student's other degree(s) or at least 450 units, whichever is greater. Interested students should meet with an economics advisor.

Honors Programs

Outstanding students are eligible for the honors programs in both the Tepper School of Business and the College of Humanities and Social Sciences. The Senior Honors Programs in Economics provide qualified students with the opportunity to engage in original research during their senior year at Carnegie Mellon. Invited students demonstrate and further develop their skills in economic analysis and research through the completion of a senior honors thesis. For many, this process of intellectual inquiry and knowledge creation is the highlight and culmination of their undergraduate academic experience. In addition to submitting a Senior Honors Thesis, the students present their work at Carnegie Mellon's annual undergraduate research symposium *Meeting of the Minds*. Students who successfully complete the Honors Program graduate with "College Honors". For more details about the Tepper Seniors Honors Program in Economics, visit the "Curricula" section of the Undergraduate Economics Program website. For details about the H&SS Honors Program, visit the "Advising & Careers" section of the H&SS Website.

Accelerated Master's Degree Programs

Accelerated Master's Degree programs enable exceptional students to earn both an undergraduate degree and a masters degree by remaining one additional year at Carnegie Mellon. The Heinz School of Public Policy and Management offers two professional accelerated masters degree programs: a Master of Science in Public Policy and Management and a Master of Information Systems Management. The Tepper School of Business offers one accelerated professional degree, Master in Business Administration, and one accelerated academic degree, Master in Quantitative Economics. Interested students should consult with their economics advisor for further information. For more details about Accelerated Master's Degree Programs, visit the "Curricula" section of the Undergraduate Economics Program website.

Degree Requirements

In addition to completing at least 360 units, the H&SS General Education requirements, and University requirements, recipients of an undergraduate degree in economics must complete courses in mathematics, probability and statistics, writing, economics theory, and economic analysis, as well as a set of advanced electives and other specialized courses. For more information, please visit the

"Curriculum" section of the Undergraduate Economics Program's website. Specific requirements for the degrees are as follows:

B.A. in Economics Curriculum

Mathematics Prerequisites	19 Units
21-120 Differential and Integral Calculus	10
21-256 Multivariate Analysis and Approximation	9
Programming Requirement	10 Units
15-100 Introductory/Intermediate Programming	10
Writing Requirement	9 Units
<i>Choose one:</i>	
73-270 Professional Writing for Economists	9
76-270 Writing in the Professions	9
76-271 Introduction to Professional and Technical Writing	9
Economic Theory Requirements	27 Units
73-100 Principles of Economics	9
73-150 Microeconomics	9
73-200 Macroeconomics	9
Economic History Requirement	9 Units
73-310 History of Economic Issues and Analysis	9
Quantitative Analysis Requirements	45 Units
36-201 Statistical Reasoning and Practice	9
36-202 Statistical Methods	9
36-303 Sampling, Survey, and Society	9
36-310 Fundamentals of Statistical Modeling	9
73-261 Econometrics	9

Advanced Economics Electives 36 Units

Students must take four advanced elective courses. Advanced elective courses are those numbered 73-300 through 73-495, as well as courses designated by the Program offered by other departments/programs. Additionally, students may work with their advisor to structure alternative sets of courses to meet these requirements based on their particular interests, subject to course availability.

Special Electives 27 Units

Students must take three special elective courses in the humanities and social sciences. The list of courses designated as special electives is maintained and revised from time to time by the Undergraduate Economics Program.

B.S. in Economics Curriculum

Mathematics Requirements 29 Units

Complete all of following:

21-120 Differential and Integral Calculus	10
21-122 Integration, Differential Equations and Approximation	10
21-259* Calculus in Three Dimensions	9

*21-256 (Multivariate Analysis and Approximation) can be substituted for 21-259.

Programming Requirement 10 Units

15-100 Introductory/Intermediate Programming	10
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Quantitative Analysis Requirements 45 Units

Choose one option:

Option 1:	
36-202 Statistical Methods	9
36-310 Fundamentals of Statistical Modeling	9
73-261 Econometrics	9

Option 2:	
36-225* Introduction to Probability and Statistics I	9
36-226 Introduction to Probability and Statistics II	9
73-261 Econometrics	9

*Acceptable equivalents for 36-225 are 21-325 and 36-217.

Writing Requirement 9 Units

Choose one:

73-270 Professional Writing for Economists	9
76-270 Writing in the Professions	9
76-271 Introduction to Professional and Technical Writing	9

Economic Theory Requirements 39 Units

Complete all of following:

73-100 Principles of Economics	
73-150 Microeconomics	9
73-200 Macroeconomics	9
73-252 Advanced Microeconomic Theory	6
73-253 Advanced Macroeconomic Theory	6

Advanced Economics Electives 45 Units

Students must take five advanced elective courses, at least two of which have 73-252 or 73-253 as a prerequisite. Advanced elective courses are those numbered 73-300 through 73-495. For the purpose of these requirements, the Undergraduate Economics Program may also designate as advanced electives courses from other departments/programs. Additionally, students may work with their advisor to structure alternative sets of courses to meet these requirements based on their particular interests, subject to course availability.

Senior Project 9 Units

73-497 Senior Project	9
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B.S. in Economics and Statistics Curriculum

I. Prerequisites

Mathematics Foundations 38 Units

Complete all of the following:

21-120 Differential and Integral Calculus	10
21-122 Integration, Differential Equations, and Approximations	10
21-259* Calculus in Three Dimensions	9
21-241 Matrix Algebra	9

*21-256 (Multivariate Analysis and Approximation) can be substituted for 21-259.

Statistical Foundations 18 Units

Complete all of the following:

36-201* Introduction to Statistical Reasoning and Practice	9
and one of the following:	
36-202 Statistical Methods	9
36-208 Regression Analysis	9
36-309 Experimental Design for Behavioral and Social Sciences	9

* Acceptable equivalents for 36-201 are 36-207, 36-220, 36-247, and 70-207

Writing Requirement 9 Units

Choose one:

73-270 Writing for Economists	9
76-270 Writing in the Professions	9
76-271 Introduction to Professional and Technical Writing	9

II. Disciplinary Core

Economics Core 39 Units

73-100 Principles of Economics	9
73-150 Microeconomics	9
73-200 Macroeconomics	9
73-252 Advanced Microeconomic Theory	6
73-253 Advanced Macroeconomic Theory	6
73-261 Econometrics	9

Statistics Core 36 Units

36-225 Introduction to Probability and Statistics I	9
36-226 Introduction to Probability and Statistics II	9
36-401 Modern Regression	9
36-402 Advanced Data Analysis (Project Course)	9

Economic Electives 18 Units

Students must take two advanced economic elective courses. Advanced elective courses are those courses numbered 73-300 through 73-495.

Statistics Electives 18 Units

Students must take two courses at the 36-300 level or above.

Additional Major in Economics Curriculum

The requirements for an additional major in Economics are the same as those for the B.S. in Economics, except that the H&SS general education requirements are waived. In order to avoid "double counting" issues, students are encouraged to meet with an economics advisor.

Minor in Economics

The requirements for a minor in Economics consist of mathematics requirements, probability and statistics requirements, and economics courses listed below. In order to avoid "double counting" issues, students are encouraged to meet with an economics advisor.

Mathematics Requirements 19 Units

21-120 Differential and Integral Calculus 10

Choose one:

21-256 Multivariate Analysis and Approximation 9
21-259 Calculus in Three Dimensions 9

Economic Theory Requirements 27 Units

Complete all of the following:

73-100 Principles of Economics 9
73-150 Microeconomics 9
73-200 Macroeconomics 9

Quantitative Analysis Requirements 27 Units

Choose one option:

Option 1:

36-202 Statistical Methods 9
36-310 Fundamentals of Statistical Modeling 9
73-261 Econometrics 9

^a Acceptable equivalents for 36-201 are 36-207, 36-330, 36-247, and 70-207.

Option 2:

36-225^b Introduction to Probability and Statistics I 9
36-226 Introduction to Probability and Statistics II 9
73-261 Econometrics 9

^b Acceptable equivalents for 36-225 are 21-325 and 36-217.

Advanced Economics Electives 18 Units

Students must take two advanced elective courses. Advanced elective courses are those numbered 73-300 through 73-495, as well as courses designated by the program offered by other departments/programs. Additionally, students may work with their advisor to structure alternative sets of courses to meet these requirements based on their particular interests, subject to course availability.

Sample Course Schedules

What follows are sample four-year course schedules for a student pursuing undergraduate degrees in Economics. As there are many different ways of completing the requirements, students are strongly encouraged to meet with an economics advisor to tailor their courses to their own particular needs. It is the responsibilities of the students to ensure that they understand all of the program requirements and that they meet the necessary conditions for graduation. When planning course schedules, students must give consideration to all prerequisite and corequisite requirements. Course descriptions, prerequisites, and corequisites can be found at the back of this catalog.

Sample Schedule for B.A. in Economics**First Year**

	Fall	49 Units
21-120	Differential and Integral Calculus	10
36-201	Statistical Reasoning	9
73-100	Principles of Economics	9
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
xx-xxx	Freshman Seminar	9

Spring 46 Units

15-100	Introductory/Intermediate Programming	10
21-259	Calculus in Three Dimensions	9
36-202	Statistical Methods	9
73-150	Microeconomics	9
79-104	World History	9

Second Year

	Fall	45 Units
36-310	Fundamentals of Statistical Modeling	9
73-200	Macroeconomics	9
xx-xxx	"Special" elective	9
xx-xxx	elective	9
xx-xxx	elective	9

Spring 45 Units

36-303	Sampling, Survey and Society	9
73-270	Writing for Economists	9
73-310	History of Economic Issues and Analysis	9
xx-xxx	elective	9
xx-xxx	elective	9

Third Year

	Fall	45 Units
73-261	Econometrics	9
xx-xxx	Advanced Economics Elective	9
xx-xxx	"Special" elective	9
xx-xxx	Advanced Economics Elective	9
xx-xxx	elective	9

Spring 45 Units

xx-xxx	Advanced Economics Elective	9
xx-xxx	"Special" Elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9

Fourth Year

	Fall	45 Units
xx-xxx	Advanced Economics Elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9

Spring 45 Units

xx-xxx	Advanced Economics Elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9

Sample Schedule for B.S. in Economics

First Year		
Fall		49 Units
21-120	Differential and Integral Calculus	10
36-201	Statistical Reasoning	9
73-100	Principles of Economics	9
76-101	Interpretation and Argument	9
99-101	Computing @ Carnegie Mellon	3
xx-xxx	Freshman Seminar	9
Spring		46 Units
15-100	Introductory/Intermediate Programming	10
21-259	Calculus in Three Dimensions	9
36-202	Statistical Methods	9
73-150	Microeconomics	9
79-104	World History	9
Second Year		
Fall		46 Units
21-122	Integration, Differential Equations and Approximation	10
73-200	Macroeconomics	9
36-310	Fundamentals of Statistical Modeling	9
xx-xxx	elective	9
xx-xxx	elective	9
Spring		48 Units
73-252/3	Advanced Economic Theory ^c	12
73-270	Writing for Economists	9
xx-xxx	Advanced Economics Elective	9
xx-xxx	elective	9
xx-xxx	elective	9

^c A semester-long sequence consisting of two mini-courses, 73-252 Advanced Microeconomic Theory and 73-253 Advanced Macroeconomic Theory.

Third Year		
Fall		45 Units
73-261	Econometrics	9
xx-xxx	Advanced Economics Elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9
Spring		45 Units
xx-xxx	Advanced Economics Elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9
Fourth Year		
Fall		45 Units
79-497	Senior Project	9
xx-xxx	Advanced Economics Elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9
Spring		45 Units
xx-xxx	Advanced Economics Elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9
xx-xxx	elective	9

Sample Schedule for B.S. in Economics and Statistics

Year	Fall	Spring
Freshman	21-120 36-201 ----- ** ----- -----	21-122 36-202 73-150 ----- -----
Sophomore	21-256 36-225 73-200 ----- -----	21-241 36-226 73-252/3 ----- -----
Junior*	36-401 73-261 Writing Req. Econ Elective -----	36-402 Stats Elective ----- ----- -----
Senior	Stats Elective ----- ----- ----- -----	Econ Elective ----- ----- ----- -----

* A student could spend, for example, year 3 abroad and move year 3 courses to year 4.

** In each semester, ----- represents other courses (not related to the major) which are needed in order to complete the 360 units that the degree requires.

Faculty

LAURENCE ALES, Assistant Professor of Economics — Ph.D., University of Minnesota; Carnegie Mellon, 2008—.

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BENNETT T. MCCALLUM, H. J. Heinz Professor of Economics — Ph.D., Rice University; Carnegie Mellon, 1981—.

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Carnegie Mellon
University in
Qatar

Carnegie Mellon University in Qatar

Charles E. Thorpe, *Dean of Carnegie Mellon University in Qatar*
 John G. Robertson, *Assistant Dean for Academic Affairs*
<http://www.qatar.cmu.edu/>

Carnegie Mellon University in Qatar is Carnegie Mellon's first undergraduate branch campus. The campus opened in 2004 as part of a collaborative effort with the Qatar Foundation to bring outstanding American education programs to the Middle East. The University shares their commitment to maintain the same quality of instruction and standard of student performance demanded on the main campus.

The campus offers three academic programs, Business Administration, Computer Science, and Information Systems. To learn more about them, see their main campus college sections in the Undergraduate Catalog. The purpose of this section is to describe the policies of the Qatar campus that are independent from those of the Pittsburgh campus and outline procedures that are common to students in all programs in Qatar.

Degree Offerings

Carnegie Mellon in Qatar offers three undergraduate degrees:

- Bachelor's of Science in Business Administration
- Bachelor's of Science in Computer Science
- Bachelor's of Science in Information Systems

Policy Statement

Carnegie Mellon in Qatar complies with common University policies unless otherwise noted. The curriculum requirements for the Business Administration, Computer Science, and Information Systems majors are identical to those of the Tepper School of Business, the School of Computer Science and the College of Humanities and Social Sciences. The same Academic Standards and

Actions apply to all programs.

Suggested Course Sequence and General Education Requirements

What follows are suggested course sequences for the BA, CS, and IS curriculums for Qatar campus students. These sequences vary in some cases in the order that students take courses from the suggested sequence on the main campus but meet the same four-year course requirements. Following the suggested course sequence for each major is a list of courses taught on the Qatar campus that meet each majors general education requirements. Not all courses are taught every semester or year. Students are strongly encouraged to meet with their advisor every semester to ensure that they are making normal progress towards a degree. They should be careful to observe any prerequisite and co-requisite requirements for each course. These are in the course descriptions found at the back of the Undergraduate Catalog and on-line.

Business Administration Suggested Course Sequence

The Business Administration suggested course sequence includes placeholders for depth courses for a business track. Students may replace these courses with those of a different approved minor or additional major.

Freshman Year		Units
	Fall	
21-111	Calculus I	10
70-100	Introduction to Business	9
70-201	Professional and Service Projects*	
76-101	Interpretation and Argument	9
79-104	Introduction to World History	9
99-104	Carnegie Skills Workshop	3
xx-xxx	Breadth course	9
		49

* Business majors must complete 70-201, Professional and Service Projects, by the end of the sophomore year. Transfer students must complete the course within two years after entering the BA Department. The course involves career-related and service activities in which the student participates over a period lasting as long as four semesters. Students should not register until the semester in which they expect to complete their activities. This course does not count in determining whether business majors are carrying a full load.

Spring		Units
15-100	Intro/Inter Programming	10
Or		
15-105	Principles of Computation	9
21-112	Calculus II	10
73-100	Principles of Economics	9
xx-xxx	Breadth course	9
xx-xxx	Breadth course	9
		47

Sophomore Year		Units
	Fall	
21-256	Multivariate Analysis and Approximation	9
70-122	Introduction to Accounting	9
70-207	Probability & Statistics for Business	9
73-150	Microeconomics	9
xx-xxx	Breadth course	9
		45

Spring		Units
21-257	Models and Methods of Optimization	9
70-208	Regression & Forecasting	9
70-311	Organizational Behavior	9
70-340	Business Communications	9
73-200	Macroeconomics	9
		45

Junior Year		Units
	Fall	
70-371	Production and Operations Management	9
70-381	Marketing	9
70-451	Management Information Systems	9
70-391	Finance	9
xx-xxx	Breadth course	9
		45

Spring		Units
70-332	Business and Society	9
70-345	Oral Communications	9
xx-xxx	Breadth course	9
xx-xxx	Depth Course	9
xx-xxx	Depth course	9
		45

Senior Year		Units
	Fall	
xx-xxx	Depth course	9
xx-xxx	Depth course	9
xx-xxx	Breadth Course	9
xx-xxx	Elective	9
xx-xxx	Elective	9
		45

Spring		Units
70-401	Management Game	12
xx-xxx	Depth course	9
xx-xxx	Depth course	9
xx-xxx	Elective	9
xx-xxx	Elective	9
		48

Minimum number of units required for the degree: 364

General Education for Business Administration

Requirements, one course from each category; two additional courses from any of the categories

1 Writing

76-101 Interpretation and Argument

1 World History

79-104 World History

1 Science & Technology

03-121 Modern Biology

09-105 Chemistry

15-211 Fundamental Data Structures & Algorithms

15-212 Principles of Programming

16-100 Intro to Robotics

16-200 Autonomous Robots

33-106 Physics for Engineering

QT-107 General Chemistry

1 Cognition, choice and Behavior

76-244 World English

76-276 Effective Interpersonal Comm.

85-102 Introduction to Psychology

85-241 Social Psychology

QC-111 Psychology

1 Political & Social Institutions

48-576 Mapping Urbanism

79-299 US & Arab Encounters

88-104 Decision Process in A.P.I

88-212 Decision making

88-388 Design. Policies to Control IS

QG-108 US Political Systems

QT-206 American National Government

QT-207 State and Local Government

QT-331 Intro to World politics

1 Creative Production and Reflection

48-095 Architecture for Non-majors

51-261 Communication Design Fun.

51-276 Sustainable Systems Design

76-274 The Writer's Craft

76-399 Bridging Civilizations: Trans.

82-141 Elementary Spanish I

82-142 Elementary Spanish II

82-241 Intermediate Spanish I

82-242 Intermediate Spanish II

QG-101 Intro to French I

QV-114 Art History

QV-116 Women in Film

QV-474 Topics in Film: beyond West

QV-489 Top. Advanced Art History

QV-491 Jewelry for Non-majors

1 Cultural Analysis

48-577 Middle Eastern Cities

70-513 Topics in B.H.: Gulf History

76-221 Studies in Classical literature

76-299 18th Cen. Discourse acct.

76-310 Quest for identity

76-358 Social & Ling. Asp. Of Immigration

79-212 Disastrous Encounters

79-214 18th Century Euro. History

79-374 Europe and Islamic World

79-381 Social Movements & Democracy

79-393 Inward Odyssey

80-100 What Philosophy Is

QV-112 Anthropology

1 information Literacy Course

99-104 Carnegie Skills Workshop

Computer Science Suggested Course Sequence

Qatar Campus Computer Science students are not required to complete a minor to graduate. They should consult with their academic advisor to make the best selection of courses from available electives.

Freshman Year		Units
Fall		
15-100	Introductory Programming	10
15-103	Principles of Computation	6
15-128	Freshman Immigration Course	1
21-111	Calculus I	10
76-101	Interpretation and Argument	9
79-104	Introduction to World History	9
99-104	Carnegie Skills Workshop	3

48

Spring		Units
15-111	Advanced Programming	9
21-112	Calculus II	10
21-127	Concepts of Mathematics	9
73-100	Principles of Economics	9
xx-xxx	Engineering and Natural Science	9

46

Sophomore Year		Units
Fall		
15-211	Fundamental Data Structures/Algorithms	12
21-241	Matrix Algebra	9
21-256	Multivariate Analysis and Approximation	9
15-251	Theory Foundation	12
xx-xxx	Humanities and Arts Elective	9

51

Spring		Units
15-123	Systems Skills in C	9
15-212	Programming Foundation	12
21-257	Models and Methods of Optimization	9
xx-xxx	Engineering and Natural Science	9
xx-xxx	Humanities and Arts Elective	9

48

Junior Year		Units
Fall		
15-213	Introduction to Computer Systems	12
15-xxx	Computer Science Elective	9/12
xx-xxx	Elective	9
xx-xxx	Engineering and natural Science	9
xx-xxx	Humanities and Arts Elective	9

48/51

Spring		Units
15-xxx	Computer Science Elective	9/12
15-xxx	Computer Science Elective	9/12
36-217	Probability Theory and Random Processes	9
xx-xxx	Humanities and Arts Elective	9
xx-xxx	Engineering and Natural Science	9

45/51

Senior Year		Units
Fall		
15-451	Algorithm Design and Analysis	12
15-xxx	Computer Science Elective	9/12
xx-xxx	Elective	9
xx-xxx	Humanities and Arts Elective	9

39/42

Spring		Units
15-xxx	Computer Science Elective	9/12
15-xxx	Computer Science Elective	9/12
xx-xxx	Elective	9
xx-xxx	Elective	9

36/42

Minimum number of units required for the degree: 360

General Education for Computer Science

4 Engineering or Natural Science*

03-121 Modern Biology
09-105 Chemistry
16-100 Intro to Robotics
16-200 Autonomous Robots
33-106 Physics for Engineering
QT-107 General Chemistry

*2 must be from same department
and 1 must be a lab course

1 Information Literacy Course

99-104 Carnegie Skills Workshop

1 Writing

76-101 Interpretation and Argument

1 Cognition, Choice and Behavior

70-311 Organizational Behavior
76-244 World English
76-276 Effective Interpersonal Comm.
85-102 Introduction to Psychology
85-241 Social Psychology
QC-111 Psychology

1 Economic, Political, & Social Institutions

48-576 Mapping Urbanism
70-332 Business, society & ethics
73-100 Principles of Economics
73-150 Microeconomics
80-210 Logic and Proofs
88-104 Decision Process in A.P.I
88-212 Decision making
88-388 Design. Policies to control IS
QG-108 US Political Systems
QT-206 American national Government
QT-207 State and Local Government
QT-331 Intro to World politics

1 cultural analysis

48-577 Middle Eastern Cities
76-221 Studies in Classical literature
76-310 Quest for Identity
76-358 Social & Ling. Aspects of Immigration
79-104 World History
79-212 Disastrous Encounters
79-214 18th Century Euro. History
79-374 Europe and Islamic World
79-381 Social Movements & Democracy
79-393 Inward Odyssey
80-100 What Philosophy Is
QV-112 Anthropology

4 Non-CS or IS, non-technical courses

see advisor for approval of these courses

Information Systems Suggested Course Sequence

Freshman Year

	Fall	Units
15-100	Introduction to Programming	10
21-111	Calculus I 10	
76-101	Interpretation and Argument	9
79-104	Introduction to World History	9
99-104	Carnegie Skills Workshop	3
67-102	Concepts of Information Systems	9
		50

Spring

15-111	Intermediate/Advanced Programming	10
21-112	Calculus II	10
73-100	Principles of Economics	9
76-318	Communicating in the Global marketplace	9
xx-xxx	Laboratory Science or elective	9/12
		47/50

Sophomore Year

	Fall	Units
21-256	Multivariate Analysis	9
70-207	Probability & Statistics for Business Applications	9
51-261	Communication Design Fundamentals	9
67-250	Information Systems Milieux	9
xx-xxx	General Education course or elective	9
		45

Spring

70-311	Organizational Behavior	9
70-208	Regression Analysis	9
67-272	Application Design & Development	9
73-150	Microeconomics	9
76-270	Writing in the Professions	9
		45

Junior Year

	Fall	Units
67-371	Fundamentals of Systems Development	9
76-487	Online Information Design	9
xx-xxx	IS Content Area course	9
xx-xxx	General Education course or elective	9
xx-xxx	General Education course or elective	9
		45

Spring

67-373	Software Development Project	12
xx-xxx	IS Content Area course	9
xx-xxx	General Education course or elective	9
xx-xxx	General Education course or elective	9
xx-xxx	General Education course or elective	9
		48

Senior Year

	Fall	Units
67-475	Information Systems Applications	12
xx-xxx	IS Content Area course	9
xx-xxx	General Education course or elective	9
xx-xxx	General Education course or elective	9
		39

Spring

67-326	Global Project management	12
xx-xxx	General Education course or elective	9
xx-xxx	General Education course or elective	9
xx-xxx	General Education course or elective	9
		39

Minimum number of units required for the degree: 360

General Education for Information Systems

Requirements, one course from each category; two additional courses from any of the categories

1. Communicating: Language and Interpretations

1 Writing

76-101 Interpretation and Argument

1 Communications

76-100 Intro to Reading and Writing
76-244 World English
76-276 Effective Interpersonal Comm.
76-399 Bridging Civilizations: trans.
82-141 Elementary Spanish I
82-142 Elementary Spanish II
82-241 Intermediate Spanish I
82-242 Intermediate Spanish II
QG-101 Intro to French I
QV-116 Women in Film
QV-474 Topics in Film: beyond West

2. Reflecting: Societies and Culture

2 courses

1 World History

79-104 World History

1 Cultural Analysis

48-577 Middle Eastern Cities

70-513 Topics in B.H.: Gulf History

76-221 Studies in Classical literature

76-250 Global Literature

76-299 18th Cen. Discourse acct.

76-310 Quest for identity

76-358 Social & Ling. Asp. Of Immigration

79-212 Disastrous Encounters

79-214 18th Century Euro. History

79-299 US & Arab Encounters

79-374 Europe and Islamic World

79-381 Social Movements & Democracy

79-393 Inward Odyssey

80-100 What Philosophy Is

QV-112 Anthropology

3. Modeling: Mathematics and Experiments

1 Natural Science

03-121 Modern Biology

09-105 Chemistry

16-100 Intro to Robotics

16-200 Autonomous Robots

33-106 Physics for Engineering

QT-107 General Chemistry

4. Deciding: Social Science and Value

1 CCB/ESPI

48-576 Mapping Urbanism

73-100 Principles of Economics

80-210 Logic and Proofs

85-102 Introduction to Psychology

85-241 Social Psychology

88-104 Decision Process in A.P.I

88-212 Decision making

88-388 Design. Policies to Control IS

QC-111 Psychology

QG-108 US Political Systems

QT-206 American national Government

QT-207 State and Local Government

QT-331 Intro to World politics

5. Creating: Designs and Productions

2 Design

48-095 Architecture for Non-majors

51-261 Communication Design Fun.

51-276 Sustainable Systems design

76-274 The Writer's craft

6. Additional Gen ED category courses

1 Information Literacy Course

99-104 Carnegie Skills Workshop

1 Freshman Seminar

67-101 Concepts of Info. Systems

Academic Standards and Actions

Academic standards and actions apply to all programs

Academic Actions

Students carrying either a full-time course load (defined as 36 or more factorable units) or a part-time course load (defined as fewer than 36 factorable units) are subject to academic actions.

Dean's List

Students earn Dean's List recognition in a given semester by achieving one of two minimum standards. They must either earn a semester QPA of 3.75 or higher (while taking at least 36 factorable units and receiving no incompletes) or earn a semester QPA of 3.50 or higher (while taking at least 45 factorable units and receiving no incompletes).

Other Actions

Students are subject to academic actions if they fail to make minimal progress toward their degree. Minimal progress is achieving a semester QPA of at least a 2.00. Students who begin a semester enrolled in 36 or more units and later drop below 36 units are subject to academic action regardless of their semester QPA.

The criteria for first year students are different – they are not subject to academic actions unless their semester QPA is below 1.75.

Probation

Probation occurs when a student's semester record fails to meet the minimal standards listed above. Students remove themselves from probation if they complete at least 36 factorable units and raise their cumulative QPA above a 2.00 (minus the first year if that is higher). The school may continue a student's probation if the student's cumulative record does not meet minimum standards but their semester record suggests that they may do so by the end of the next semester.

Suspension

If a student fails to meet the minimal standards stated above at the end of the probation semester, the school will suspend them. Suspension is for a minimum of one year and the student is required to follow University procedures for departing from campus. At the end of the year, the student may petition to return to Carnegie Mellon by completing the following steps:

1. Ask the Assistant Dean for Academic Affairs in writing for permission to resume their studies.
2. Submit a completed Return from Leave of Absence Form to the registrar.
3. Provide transcripts for any courses taken at other colleges or universities during the suspension even though academic credits earned during a suspension do not transfer back to Carnegie Mellon.

To get approval to resume their studies the student must demonstrate that they are better prepared to perform above the minimum standards for graduation than before they were suspended. Students return from suspension on probation.

Drop

A student that fails to meet minimum standards at any point after returning from a suspension is subject to a drop action. A drop action is a permanent severance; the student is required to follow University procedures for departing from campus and may not enroll again in the future.

The typical progression of academic actions is Probation, Suspension, then Drop but the intent of the academic actions are to take measures that are in the student's best interest and therefore the school may bypass one or more of these steps in an unusual case.

Other Regulations Affecting Student Status

Course Overloads

A Qatar Campus student must have attained a QPA of at least 3.00 in the previous semester to carry an overload (defined as more than 51 units) of up to 62 units. If a student carrying an overload is in severe academic difficulty during the semester, the Assistant Dean for Academic Affairs may withdraw the student from the overload course.

Adding a Class

Students may add classes to their schedule under the following rules:

1. Students may only add a full semester course through the first 10 class days of the semester.
2. They may only add half semester mini courses through the first 5 class days of the course.

Withdrawing from Courses

The Qatar campus follows the Carnegie Mellon policies on withdrawing from courses:

1. Students who wish to withdraw from a course without

receiving a "W" grade must do so before the published Qatar Campus deadline. After that date, students may withdraw from a course up to the last day of classes and receive a "W" as a grade for it. After the last day of classes student may not withdraw from a class.

2. A student carrying a full-time course load (defined as at least 36 factorable units) may not drop below 36 units after the 10th regularly scheduled day of classes.

Non-Carnegie Mellon Courses

Students may receive credit for courses taken outside of Carnegie Mellon if they successfully petition the Assistant Dean for Academic Affairs in advance for permission. Students must take these courses for a letter grade and instruction must be in English for non-language courses. Credit (but not the grade) will transfer for courses with a grade equivalent to at least a "C" at some institution and at least a "B" at others as determined by the Assistant Dean for Academic Affairs. It is difficult to get transfer credit approval for Business Administration, Computer Science, Economics, Information Systems, and Mathematics/Statistics core classes. The class's course description must be a close match to the Carnegie Mellon course and from an acceptable four-year institution. Students may take breadth and elective courses at a broader range of schools including two and three year institutions as long as the course is equivalent to a similar offering at Carnegie Mellon. Students may not receive credit for any courses taken on-line.

Students may not receive credit for more than five non-CMU courses during their undergraduate career as a Carnegie Mellon student. Classes taken prior to enrolling in Carnegie Mellon, during study abroad semesters, and as cross registration with other education City schools do not count toward the credit transfer limit. All students must meet the University's residency requirement of completing at least 180 units of Carnegie Mellon coursework.

Transferring

Between majors in Qatar

Students may transfer between majors on the Qatar campus on a space available and academic performance basis. Students interested in transferring should consult with the Assistant dean for Academic Affairs. First year students may not apply for transfer until they receive their spring mid-semester grades.

Within majors between Qatar and Pittsburgh

Qatar Campus and Pittsburgh campus students wishing to transfer between campuses but within their majors should consult with their home Academic Dean. Students are not eligible to apply for transfer between campuses until they meet the following conditions. CS students must have completed 15-211, BA students 21-256, and IS students 15-111. Success of the application depends on the student's academic performance and the space available in the major on the campus they wish to join. Transfers between campuses are subject to the approval of the Academic Dean for the program on the campus that the student is seeking to join.

Transferring to Pittsburgh in majors not offered in Qatar
Students seeking to transfer to the main campus into a different major do so through those departments.

Transfers to Qatar from other Universities

Transfer students from other universities must apply through the Carnegie Mellon in Qatar Admission office. If the admission office finds the applicant admissible, they forward the application to the Assistant dean for Academic Affairs who then determines if there is space available in the program and if the student's past academic performance warrants admission.

Campus Exchange

Qatar campus and Pittsburgh campus students may study on the opposite campus for one semester on a space available basis and with the approval of both the home and host departments. Given the capacity limitation on both campuses, exchange between campuses is limited to an excess of two per cohort in any major beyond a balanced exchange. As an example, if two sophomore BA students travel from Doha to Pittsburgh in a fall semester then four sophomore BA students may travel from Pittsburgh to study in Doha that semester. Students from any major are welcome to study for a semester in Qatar but if space limitations apply, students from majors offered in Qatar have priority.

The number of students studying in Pittsburgh and Doha do not have to balance in the summer but space limitations and dual approvals still apply.

University Honors

Students maintaining a 3.5 QPA after seven semesters of full time enrollment or raising their QPA to 3.5 upon completing their graduation requirements graduate with university Honors.

College Honors

Students entering their senior year may undertake an Honors Thesis if they meet their major college's eligibility requirements. Any interested students should contact the Assistant dean for Academic Affairs for details.

Graduation Requirements

In order to graduate with a Bachelor of Science in Business Administration, Computer Science, or Information Systems students must meet all requirements specified for that program with a cumulative quality point average of at least 2.00 for all courses taken after the first year. Students must also meet all University residence requirements and meet all financial obligations to the University before receiving a degree.

A student may seek permission to modify graduation requirements by petition to the Assistant Dean for Academic Affairs.

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All courses listed in this catalog are expected to be offered in the next two years.

Course Descriptions

Descriptions accurate as of: August 12, 2008

Biological Sciences

03-050 Study Abroad
Fall: 0 units

03-051 Study Abroad
Spring: 0 units

03-101 Biological Sciences First Year Seminars
Fall and Spring: Mini Session - 3 units
Various seminars are offered that introduce first-year students to current topics of modern biology. These are mini courses that meet for half a semester. Topics have included: Proteins in Disease, Genes and Diseases, Pills and Poisons, Curing Cancer, Organ Transplantation & Blood Substitutes, and Prions — Mad Cows and Englishman. Courses restricted to first year students in the Mellon College of Science.

03-115 Phage Genomics Research
Fall: 6 units
This course will provide an introduction to biological investigation through a research project in bacteriophage genomics. Genomics combines experimental and computational approaches for large-scale analysis of the biological information contained in DNA sequences. The ability to analyze the complete DNA of any organism has revolutionized modern genetics and is influencing many areas of biology and medicine. The most abundant biological entities are bacteriophages (viruses that infect bacteria). Their enormous diversity and number make bacteriophages important models for the study of gene structure, function and regulation, population genetics and evolution. In addition they are the source of important tools in biotechnology. The research goals of this course will be to identify new bacteriophage species and incorporate them into a comparative genomic study to better understand the genetic organization and evolution of these organisms. While accomplishing these goals students will develop an understanding of the research process, including the ability to design experiments and interpret novel data. Fall semester: Samples will be collected in the field. From these samples students will identify and purify bacteriophages. The bacteriophages will be characterized structurally by electron microscopy, and their DNA will be purified and sequenced.

03-116 Phage Genomics Research
Spring: Mini Session - 6 units
Spring Semester: The DNA sequences will be analyzed with bioinformatic tools and compared with those of phages isolated at other locations to identify genes, their organization, the differences that may characterize different phage groups, and how these have arisen during evolution.

03-121 Modern Biology
Fall and Spring: 9 units
This is an introductory course that provides the basis for further studies in biochemistry, cell biology, genetics and molecular biology. This course emphasizes the chemical principles underlying biological processes and cell structures as well as the analysis of genetics and heredity from a molecular perspective. This is the introductory biology course for all science and non-science majors.

03-122 Organismic Botany
Spring: 9 units
This course provides an integrated overview of botany at the level of organism and above, including historical perspectives. It provides an introduction to the subdisciplines of systematics, evolution, plant geography, and ecology, and surveys the anatomical, morphological, developmental, and environmental diversification of major groups within the plant kingdom.
Prerequisites: 03121

03-124 Modern Biology Laboratory
Fall and Spring: 9 units
This laboratory is designed to introduce students to modern concepts in the biological sciences. The experiments illustrate many of the principles covered in 03-121 and 03-130. Experimentation using living organisms and/or their tissues, cells or molecules is an essential component of this course. Special permission required.
Corequisites: 03-121

03-125 Evolution and History of Life
Intermittent: 9 units
This course surveys the pattern and process of biological evolution. Major topics include: historical recognition of evolutionary pattern (biological diversity in geological time); foundation theory of evolutionary process; relationships of the major domains/kingdoms of life; early Earth and prebiotic evolution; origin of nucleic acids and self-replication; origin of prokaryotes; endosymbiosis and origin of the eukaryotic cell; origin and evolution of protocists, fungi, plants, and animals; modern theory of evolutionary process, including microevolution, speciation, and macroevolution; relationship of evolution and systematics; molecular approaches to the study of evolution and the construction of phylogenies.
Prerequisites: 03121

03-201 Undergraduate Colloquium for Sophomores
Fall: 1-3 units
The purpose of this seminar series is to update biology undergraduates about university and departmental functions, seminars, etc. that are pertinent or useful. In addition, research talks by faculty and undergraduates will be used to introduce students to the research being conducted in faculty laboratories. Additional topics may include graduate and medical school applications, career options, topics in the press, and important scientific discoveries.

03-202 Undergraduate Colloquium for Sophomores
Spring: 1-3 units

03-210 Independent Study
Fall and Spring: Mini Session - 1-12 units
Students will read papers from the original literature under the direction of a faculty member. Students will be required to demonstrate mastery of the readings by discussions with the sponsoring faculty member, oral presentations, or writing of one or more papers summarizing and extending the information in the readings. If appropriate, students may write a program(s) to satisfy this last requirement. A student may take this course only once. Special permission required.

03-230 Intro to Mammalian Physiology
Spring: 9 units
This course will survey the major organ systems, with an emphasis on cellular physiology and biochemistry. Current ideas of research and scientific controversy will also be presented. This course is intended to broaden students' exposure to cellular processes in the context of complex organ systems.

03-231 Biochemistry I
Fall: 9 units
This course provides an introduction to molecules and processes found in living systems. Amino acids, sugars, lipids and nucleotides and their corresponding higher structures, the proteins, polysaccharides, membranes and nucleic acids are studied. Kinetics and mechanisms of enzymes as well as elementary metabolic cycles and the energetics of biological systems are discussed.
Prerequisites: 03121 Corequisites: 09-217

03-232 Biochemistry I
Spring: 9 units
This course provides an introduction to the application of biochemistry to biotechnology. The functional properties of amino acids, nucleotides, lipids, and sugars are presented. This is followed by a discussion of the structural and thermodynamic aspects of the organization of these molecules into higher-order structures, such as proteins, nucleic acids, and membranes. The kinetics and thermodynamics of protein-ligand interactions are discussed for non-cooperative, cooperative, and allosteric binding events. The use of mechanistic and kinetic information in enzyme characterization and drug discovery are discussed. Topics pertinent to biotechnology include: antibody production and use, energy production in biochemical systems, expression of recombinant proteins, and methods of protein purification and characterization. The course is an alternate to 03-231.
Prerequisites: 09217 Corequisites: 09-106, 06-221

03-240 Cell Biology

Spring: 9 units

This course provides descriptive information and mechanistic detail concerning key cellular processes in six areas: membrane function, protein targeting, signaling, cytoskeleton, cell division, and cell interaction. An attempt is made to introduce the methodology that was used to obtain this information and to discuss how our understanding of these processes relates to the treatment of human disease.

Prerequisites: 03121 and (03231 or 03232)

03-301 Undergraduate Colloquium for Juniors

Fall: 1-3 units

03-302 Undergraduate Colloquium for Juniors

Spring: 1-3 units

03-310 Introduction to Computational Biology

Fall: 9 units

This course covers the application of computers to solve problems in biology and medicine. Since computers are increasingly used in biological research, the course is valuable for all biological sciences majors and interested students from other departments. It is intended for students without computer programming experience (students with a desire to apply programming methods to these problems should take the more advanced course 03-510, Computational Biology). Topics covered are computational molecular biology (analysis of protein and nucleic acid sequences), biological modeling and simulation (including computer models of neuron behavior, biochemical kinetics, and simulation of mutation), and biological imaging. Course work consists primarily of homework assignments making use of software packages for these applications. Students may only use one of the following for credit, 03-310, 03-311, 03-510 or 03-710.

Prerequisites: (21118 or 21112) AND 03121 AND (99101 or 99102 or 99103)

03-311 Introduction to Computational Molecular Biology

Spring: Mini Session - 6 units

This course presents both the theoretical underpinnings of computational methods used in modern molecular biology and practical training in using these methods and the data resources to which they can be applied. It is intended for students without computer programming experience. Topics included are biological sequencing and databases, sequence searching and alignment, protein structure, whole genome resources, genetic variations and their relationship to phenotype, gene and protein expression, and biological networks and pathways. Course work consists primarily of homework assignments making use of online resources for these applications. Students may only use one of the following for credit, 03-310, 03-311, 03-510 or 03-710.

Prerequisites: 03121 and (99101 or 99102 or 99103)

03-315 Magnetic Resonance Imaging in Neuroscience

Spring: 9 units

The course is designed to introduce students to the fundamental principles of magnetic resonance imaging (MRI) and its application in neuroscience. MRI is emerging as the preeminent method to obtain structural and functional information about the living human brain. This methodology has helped to revolutionize neuroscience and the study of human cognition. The specific topics covered in this course will include: introduction to spin gymnastics, survey of imaging methods, structural brain mapping, functional MRI (fMRI), and MR spectroscopy (MRS). Approximately, one third of the course will be devoted to introductory concepts of magnetic resonance, another third to the discussion of MRI methods, and the remaining third will cover a broad range of neuroscience applications. Guest lectures will be incorporated into the course from neuroscientists and psychologists who use MRI in their own research.

Prerequisites: 03121 AND (21117 or 21121 or 21122)

03-325 Evolution

Fall: 9 units

Evolution is the unifying theory of biology. This course will provide a broad coverage of the concepts of evolution but will especially focus on the molecular basis of evolutionary change. Topics will include (i) the history of evolutionary theories, before and after Darwin, and the evidence for evolution; (ii) the origins and radiations of key phylogenetic nodes including, life, multicellularity, animals, and mammals (iii) adaptation, fitness, variation and natural selection, (iv) evolution and development of animal body plans, and (v) cis-regulatory evolution and gene regulatory networks.

The main objective of the course is for students to gain a thorough understanding of the evolutionary, molecular basis of the diversity and origins of life. Additionally, by the end of the course students

should have gained a deeper understanding of all areas of biology through an appreciation of underlying historical processes.

Prerequisites: 03121 Corequisites: 03-330

03-330 Genetics

Fall: 9 units

The mechanisms of transmission of inherited traits in viruses, bacteria, fungi, plants and animals are discussed. Molecular mechanisms of gene expression and gene regulation are analyzed. Recombinant DNA and its applications in genetic analysis, biotechnology, forensics, agriculture, medicine, and the pharmaceutical industry are presented. Special topics in human genetics are considered, such as the genetics of cancer. Principles and methods for the study of developmental genetics, population genetics and complex traits are also introduced.

Prerequisites: 03231 or 03232

03-343 Experimental Techniques in Molecular Biology

Fall: 12 units

This laboratory course is designed to teach experimental methods of modern biology. Experiments in microbial genetics, molecular biology and eukaryotic genetics are performed. Emphasis is placed on understanding and applying the biological principles of each experiment. This course is designed to be taken during the junior year and is intended to prepare students for undergraduate research. Experimentation using living organisms and/or their tissues, cells or molecules is an essential component of this course.

Prerequisites: (03231 or 03232) and 09222 Corequisites: 03-330

03-344 Experimental Biochemistry

Spring: 12 units

This course is designed to be taken as a sequel to 03-343. Experiments cover a variety of methods for investigating the structure and function of biological molecules. Experimental methods with proteins, enzyme kinetics, lipids, spectroscopy, and isolation and quantization of biological molecules are covered. During several experiments, students design their own projects. Experimentation using living organisms and/or their tissues, cells or molecules is an essential component of this course.

Prerequisites: (03231 or 03232) and 03343

03-345 Experimental Cell and Developmental Biology

Spring: 12 units

This laboratory is designed to teach concepts and experimental methods in cell and developmental biology. Students work with a variety of organisms to examine how cells traverse development from rapidly dividing, undifferentiated cells, through cell commitment and the establishment of spatial and temporal patterns of gene expression, to the specific characteristics and responses of terminally differentiated cells. The course makes extensive use of video microscopy with phase contrast, DIC and fluorescence microscopes. Biochemical, immunological and molecular biological techniques are used to probe the molecules and processes of cells undergoing development. Experimentation using living organisms and/or their tissues, cells or molecules is an essential component of this course.

Prerequisites: (03231 or 03232) and 03240 and 03330 and 03343

03-350 Developmental Biology

Fall: 9 units

Developmental biology is the study of how organisms arise from a single cell — the fertilized egg. The molecular pathways that control development also underlie many human diseases. Developmental biology encompasses stem cell biology, cell-cell signaling, regulation of gene expression, gene networks, morphogenesis, and cell/tissue differentiation. This course serves as an introduction to the major concepts, experimental methodologies, research questions, and model organisms in developmental biology.

Prerequisites: 03240

03-362 Cellular Neuroscience

Fall: 9 units

Modern neuroscience is an interdisciplinary field that seeks to understand the function of the brain and nervous system. This course provides a comprehensive survey of cellular and molecular neuroscience ranging from molecules to simple neural circuits. Topics covered will include the properties of biological membranes, the electrical properties of neurons, neural communication and synaptic transmission, mechanisms of brain plasticity and the analysis of simple neural circuits. In addition to providing information the lectures will describe how discoveries were made and will develop students' abilities to design experiments and interpret data.

Prerequisites: 03121

03-363 Systems Neuroscience

Spring: 9 units

Modern neuroscience is an interdisciplinary field that seeks to understand the function of the brain and nervous system. This course provides a comprehensive survey of systems neuroscience, a rapidly growing scientific field that seeks to link the structure and function of brain circuitry to perception and behavior. This course will explore brain systems through a combination of classical, Nobel prize-winning data and cutting edge primary literature. Topics will include sensory systems, motor function, animal behavior and human behavior in health and disease. Lectures will provide fundamental information as well as a detailed understanding of experimental designs that enabled discoveries. Finally, students will learn to interpret and critique the diverse and multimodal data that drives systems neuroscience.

Prerequisites: 03121

03-380 Virology

Fall: 9 units

The concepts and methods of virology are covered, with emphasis on animal viruses, within the framework of cell biology, genetics, molecular biology, immunology, pathology, and epidemiology. The strategies that a variety of different DNA and RNA viruses, including some new and emerging ones, use to replicate and express their genomes during infection of host cells will be examined. The effects that viruses inflict on these cells will also be examined, as will some of the host and host cell responses generated by such virus-cell interactions, including interferon induction, the antiviral response generated by interferon, and oncogenic transformation. In addition, an overview of procedures used for prevention and treatment of viral diseases via vaccines and antiviral drugs, respectively, will be presented, as will a brief discussion of viroids and prions, and the characteristics of these agents which distinguish them from viruses.

Prerequisites: 03240 Corequisites: 03-330

03-390 Molecular and Cellular Immunology

Spring: 9 units

This course offers the student a comprehensive view of modern immunology at the molecular and cellular level. The first half of the course presents the fundamentals of immunology, beginning with innate immunity, followed by a discussion of the structure and function of important molecules in the immune system, such as antibodies, major histocompatibility antigens, complement, and the T-cell receptor. This portion of the course is concluded with a discussion of the development and function of the cellular immune response. The second half of the course is focused on applied immunology and discusses hypersensitivity, autoimmunity, immunodeficiencies, tumor immunology, infectious disease, and transplantation immunology. Presentations at the end of the course provide an opportunity for the student to explore additional topics in contemporary immunology.

Prerequisites: (03231 or 03232) and 03240

03-401 Undergraduate Colloquium for Seniors

Fall: 1-3 units

03-402 Undergraduate Colloquium for Seniors

Spring: 1-3 units

03-410 Independent Study Biological Study

Fall and Spring: 9 units

03-411 Topics in Research

Fall and Spring: 1-2 units

During the year students attend and submit brief summaries of weekly seminars given by outside speakers or members of the Biology Department on current research topics in modern biology; some seminars outside of the department may be substituted.

03-412 Topics in Research

Spring: 1-2 units

During the year students attend and submit brief summaries of weekly seminars given by outside speakers or members of the Biology Department on current research topics in modern biology. Some seminars outside of the department may be substituted.

03-439 Introduction to Biophysics

Fall: 9 units

This course develops the physical concepts that apply to the understanding of biological systems. The forces that play roles in biological systems are discussed and the role of thermal energy is especially emphasized. Topics discussed include protein structure, helix-coil transitions, double layer potentials, membrane structure and transport, Nernst-Planck equations and electrochemical potential, molecular motors, and action potentials and voltage

sensitive channels. The capstone of the course is the study of the potassium channel in axons. The treatment of biophysical phenomena and methods is based on physical principles, which will be treated with appropriate mathematics when necessary.

Prerequisites: 03121 and 09105 and 33111 and 33112

03-442 Molecular Biology

Fall: 9 units

The structure and expression of eukaryotic genes are discussed, focusing on model systems from a variety of organisms including yeast, flies, worms, mice, humans, and plants. Topics discussed include (1) genomics, proteomics, and functional proteomics and (2) control of gene expression at the level of transcription of mRNA from DNA, splicing of pre-mRNA, export of spliced mRNA from the nucleus to the cytoplasm, and translation of mRNA.

Prerequisites: 03330

03-445 Undergraduate Research

Fall and Spring: 1-18 units

Students may investigate research problems under the supervision of members of the faculty. Permission of a faculty advisor required.

03-510 Computational Biology

Spring: 12 units

This course covers a range of applications of computers to solve problems in biology and medicine. Specific topics covered are computational molecular biology (analysis of protein and nucleic acid sequences), biological modeling and simulation (including computer models of neuron behavior, biochemical kinetics, and simulation of mutation), and biological imaging. Course work will include use of software packages for these applications, reading of scientific papers, and programming assignments. Students may only use one of the following for credit, 03-310, 03-311, 03-510 or 03-710.

Prerequisites: 03121 AND (15200 or 15211)

03-511 Computational Molecular Biology and Genomics

Fall: 9 units

An advanced introduction to computational molecular biology, using an applied algorithms approach. The first part of the course will cover established algorithmic methods, including pairwise sequence alignment and dynamic programming, multiple sequence alignment, fast database search heuristics, hidden Markov models for molecular motifs and phylogeny reconstruction. The second part of the course will explore emerging computational problems driven by the newest genomic research. Course work includes four to six problem sets, one midterm and final exam.

Prerequisites: (15211 and 03510) OR 15451

03-512 Computational Methods for Biological Modeling and Simulation

Spring: 9 units

This course covers a variety of computational methods important for modeling and simulation of biological systems. It is intended for graduates and advanced undergraduates with either biological or computational backgrounds who are interested in developing computer models and simulations of biological systems. The course will emphasize practical algorithms and algorithm design methods drawn from various disciplines of computer science and applied mathematics that are useful in biological applications. The general topics covered will be models for optimization problems, simulation and sampling, and parameter tuning. Course work will include problem sets with significant programming components and independent or group final projects.

Prerequisites: 03121 and 15211

03-513 Bioinformatics Data Integration Practicum

Spring: Mini Session - 6 units

This course will provide a practical experience in integration of bioinformatics data of diverse types in collaboration with a pharmaceutical company or biotechnology company. At the beginning of the semester, students will be presented with a description of the problem and data sets. During the semester students will work as part of independent teams to design, implement and evaluate an appropriate data integration system (with the opportunity for interaction with the company developers for advice and feedback). The course grade will be based on an oral presentation of the developed software system and a written report describing its development and evaluation. Selected students will have the opportunity to present their work to the company.

Prerequisites: (03310 or 03311 or 03510) AND 15211

03-534 Biological Imaging and Fluorescence Spectroscopy

Spring: 9 units

This course covers principles and applications of optical methods in the study of structure and function in biological systems. Topics

to be covered include: absorption and fluorescence spectroscopy; interaction of light with biological molecules, cells, and systems; design of fluorescent probes and optical biosensor molecules; genetically expressible optical probes; photochemistry; optics and image formation; transmitted-light and fluorescence microscope systems; laser-based systems; scanning microscopes; electronic detectors and cameras: image processing; multi-mode imaging systems; microscopy of living cells; and the optical detection of membrane potential, molecular assembly, transcription, enzyme activity, and the action of molecular motors. This course is particularly aimed at students in science and engineering interested in gaining in-depth knowledge of modern light microscopy. Prerequisites: (03231 or 03232) and 03240 and 09218 and (09144 or 09214)

03-545 Honors Research

Fall and Spring: 1-9 units

This semester of research consists primarily of research and preparation of an acceptable written thesis. Oral presentation and defense of the thesis research will be required. This course ordinarily will be taken in the second semester of the senior year. Permission of the research advisor required. Prerequisites: 03330

03-620 Techniques in Electron Microscopy

Spring: 9 units

This course is designed to teach basic methods in transmission electron microscopy to graduate and undergraduate students. Sophomores with an interest in electron microscopy are encouraged to enroll, and will have the option and opportunity to utilize their skills in various laboratories during their junior or senior year. The course will be offered once each year, during the spring semester. Course enrollment will be limited to 4-6 students. Preferential enrollment will be given to graduate students and undergraduate students who have demonstrated a need for this technique in their research. The class will include one hour of lecture and 4 hours of laboratory each week (some additional laboratory time outside of the scheduled laboratory time is required). Students will learn basic methods in specimen preparation for both transmission and scanning electron microscopy (fixation, embedding and ultramicrotomy, drying and metal coating) and will be trained in the operation of both the Hitachi 7100 and 2460N electron microscopes. Lectures and laboratories during the last few weeks of the semester will introduce the students to special techniques (e.g. immunoelectron microscopy, cryoultramicrotomy, freeze substitution, variable pressure SEM, etc.) and will allow them to work with samples from their own research. Experimentation using living organisms and/or their tissues, cells or molecules is an essential component of this course. Special Permission

03-700 MS Thesis Research

All Semesters: 3-36 units

An independent investigation on a project selected from a major area of research study with the advice and approval of the faculty advisor. Required of students enrolled in the Master of Science program.

03-710 Computational Biology

Spring: 12 units

This course covers a range of applications of computers to solve problems in biology and medicine. Specific topics covered are computational molecular biology (analysis of protein and nucleic acid sequences), biological modeling and simulation (including computer models of neuron behavior, biochemical kinetics, and simulation of mutation), and biological imaging. Course work will include use of software packages for these applications, reading of scientific papers, and programming assignments. Students may use one of the following courses for credit, 03-310, 03-311, 03-510 or 03-710. Prerequisites: 03121 and (15200 or 15211)

03-711 Computational Molecular Biology and Genomics

Fall: 12 units

An advanced introduction to computational molecular biology, using an applied algorithms approach. The first part of the course will cover established algorithmic methods, including pairwise sequence alignment and dynamic programming, multiple sequence alignment, fast database search heuristics, hidden Markov models for molecular motifs and phylogeny reconstruction. The second part of the course will explore emerging computational problems driven by the newest genomic research. Course work includes four to six problem sets, one midterm and final exam. A project based on recent results from the genomics literature will be required of students taking 03-711. Prerequisites: (15211 and 03510) OR 15451

03-712 Computational Methods for Biological Modeling and Simulation

Spring: 12 units

This course covers a variety of computational methods important for modeling and simulation of biological systems. It is intended for graduates and advanced undergraduates with either biological or computational backgrounds who are interested in developing computer models and simulations of biological systems. The course will emphasize practical algorithms and algorithm design methods drawn from various disciplines of computer science and applied mathematics that are useful in biological applications. The general topics covered will be models for optimization problems, simulation and sampling, and parameter tuning. Course work will include problems sets with significant programming components and independent or group final projects. Prerequisites: 03121 and 15211

03-713 Bioinformatics Data Integration Practicum

Spring: Mini Session - 6 units

This course will provide a practical experience in integration of bioinformatics data of diverse types in collaboration with a pharmaceutical company or biotechnology company. At the beginning of the semester, students will be presented with a description of the problem and data sets. During the semester students will work as part of independent teams to design, implement and evaluate an appropriate data integration system (with the opportunity for interaction with the company developers for advice and feedback). The course grade will be based on an oral presentation of the developed software system and a written report describing its development and evaluation. Selected students will have the opportunity to present their work to the company. Prerequisites: (03310 or 03311 or 03510) AND 15211

03-715 Adv. Algorithms and Models for Computational Biology: Machine Learning Approach

Spring: 9 units

Dramatic advances in experimental technology and computational analysis are fundamentally transforming the basic nature and goal of biological research. The emergence of new frontiers in biology, such as evolutionary genomics and systems biology is demanding new methodologies that can confront quantitative issues of substantial computational and mathematical sophistication. In this course we will discuss classical approaches and latest methodological advances in the context of the following biological problems: 1) Computational genomics, focusing on gene finding, motifs detection and sequence evolution. 2) Analysis of high throughput biological data, such as gene expression data, focusing on issues ranging from data acquisition to pattern recognition and classification. 3) Molecular and regulatory evolution, focusing on phylogenetic inference and regulatory network evolution, and 4) Systems biology, concerning how to combine sequence, expression and other biological data sources to infer the structure and function of different systems in the cell. From the computational side this course focuses on modern machine learning methodologies for computational problems in molecular biology and genetics, including probabilistic modeling, inference and learning algorithms, pattern recognition, data integration, time series analysis, active learning, etc.

03-725 Evolution

Fall: 12 units

Evolution is the unifying theory of biology. This course will provide a broad coverage of the concepts of evolution but will especially focus on the molecular basis of evolutionary change. Topics will include (i) the history of evolutionary theories, before and after Darwin, and the evidence for evolution; (ii) the origins and radiations of key phylogenetic nodes including, life, multicellularity, animals, and mammals (iii) adaptation, fitness, variation and natural selection, (iv) evolution and development of animal body plans, and (v) cis-regulatory evolution and gene regulatory networks. The main objective of the course is for students to gain a thorough understanding of the evolutionary, molecular basis of the diversity and origins of life. Additionally, by the end of the course students should have gained a deeper understanding of all areas of biology through an appreciation of underlying historical processes. Prerequisites: 03121 Corequisites: 03-330

03-730 Advanced Genetics

Spring: 12 units

This course considers selected current topics in genetics at an advanced level. Emphasis is on classroom discussion of research papers. Topics change yearly. Recent topics have included nucleocytoplasmic trafficking of RNA in yeast, genome imprinting in mammals, genetics of learning and memory in Drosophila, and viral genomics. Prerequisites: 03330 and (03442 or 03742)

03-738 Physical Biochemistry

Fall: 12 units

The physical properties of biological macromolecules and the methods used to analyze their structure and function are discussed. Topics covered include: protein architecture, folding and molecular evolution; nucleic acid structure; introduction to structure determination by X-ray crystallography and NMR; biological spectroscopy with emphasis on the biological applications of absorption, fluorescence, NMR, and CD spectroscopies; the kinetics and thermodynamics of protein-ligand interactions; enzyme catalysis; the use of hydrodynamics, chromatography and electrophoresis in the characterization of biological macromolecules; and analysis of biological molecules at the single molecule level. One weekly session will be devoted to the detailed analysis of related research publications.

Prerequisites: (03231 or 03232) and (09214 or 09345)

03-740 Advanced Biochemistry

Spring: 12 units

This is a special topics course in which selected topics in biochemistry will be analyzed in depth with emphasis on class discussion of papers from the recent research literature. Topics change yearly. Recent topics have included single molecule analysis of catalysis and conformational changes; intrinsically disordered proteins; cooperative interactions of aspartate transcarbamoylase; and the mechanism of ribosomal protein synthesis.

03-741 Advanced Cell Biology

Spring: 12 units

This course covers fourteen topics in which significant recent advances or controversies have been reported. For each topic there is a background lecture by the instructor, student presentations of the relevant primary research articles and a general class discussion. Example topics are: extracellular matrix control of normal and cancer cell cycles, force generating mechanisms in trans-membrane protein translocation, signal transduction control of cell motility, and a molecular mechanism for membrane fusion.

Prerequisites: (03231 or 03232) and 03240

03-742 Molecular Biology

Fall: 12 units

The structure and expression of eukaryotic genes are discussed, focusing on model systems from a variety of organisms including yeast, flies, worms, mice, humans, and plants. Topics discussed include (1) genomics, proteomics, and functional proteomics and (2) control of gene expression at the level of transcription of mRNA from DNA, splicing of pre-mRNA, export of spliced mRNA from the nucleus to the cytoplasm, and translation of mRNA.

Prerequisites: 03330

03-744 Membrane Trafficking

Spring: 9 units

While the focus of this course is to analyze membrane/protein traffic along both the biosynthetic and endocytic pathways, our general goal is to teach students how to read and interpret the literature. In particular, we emphasize the conclusions and discuss their validity. The course is updated each year to include topics in which new and interesting developments have occurred. Emphasis is placed on how membrane traffic is regulated and where applicable how it is disrupted or subverted during disease processes. The course is of general interest to students, fellows, and faculty interested in cell biology, immunology, neurobiology, pharmacology and virology.

Prerequisites: 03240

03-745 Core Course in Biochemistry

Fall: Mini Session - 6 units

This course is designed to provide first year doctoral students in the Department of Biological Sciences with a broad foundation in biochemistry and biophysical techniques. Topics include protein structure, enzymology, and methods to characterize protein structure and function. Students will be evaluated throughout the course, and with a final exam.

03-746 Core Course in Cell Biology

Fall: Mini Session - 6 units

This course is designed to provide first year doctoral students in the Department of Biological Sciences with a broad foundation in cell biology. Topics include, but are not limited to, intracellular trafficking, signal transduction, the cytoskeleton, the cell cycle, and cell-cell interactions. This is a lecture-based course and will include some discussion of the primary literature. Students will be evaluated weekly, and with a final exam.

03-751 Advanced Developmental Biology

Fall: 12 units

This course examines current topics in developmental biology at an advanced level. The course is team-taught by faculty from Carnegie Mellon University, the University of Pittsburgh Department of Biological Sciences, and the University of Pittsburgh Medical School. Each year several areas of current research are examined. Previous topics have included pattern formation, molecular signaling pathways, morphogen gradients, cell movements, and stem cells. Emphasis is on critical reading of original research papers and classroom discussion, with supporting lectures by faculty.

Prerequisites: 03350

03-761 Neuronal Plasticity: From Synapses to Systems

Spring: 9 units

Neural plasticity underlies the capacity of the central nervous system to encode new information, develop new abilities and adapt to the environment. Plasticity is required for learning and is modulated during development and by disorders of the brain. Recent advances in experimental methodology have led to new insights on the biological mechanisms underlying neural plasticity. The topics if the papers chosen for review will center on recent experimental and theoretical studies of topics such as synaptic plasticity, developmental and activity dependent changes in sensory and motor maps.

Prerequisites: 03360

03-762 Advanced Cellular Neuroscience

Fall: 9 units

This course is a graduate version of 03-362. Students will attend the same lectures as the students in 03-362, plus an additional once weekly meeting. In this meeting topics covered in the lectures are addressed in greater depth, often through discussions of papers from the primary literature. Students will read and be expected to have an in depth understanding of several classic papers from the literature including work by Hodgkin and Huxley on action potentials and by Katz and Eccles on synaptic transmission. Generation and use of genetically modified animals also will be discussed. Performance in this portion of the class will be assessed by supplemental exam questions.

Prerequisites: 03121

03-763 Advanced Systems Neuroscience

Spring: 12 units

This course is a graduate version of 03-363. Students will attend the same lectures as the students in 03-363, plus an additional once weekly meeting. In this meeting, topics covered in the lectures will be addressed in greater depth, often through discussions of papers from the primary literature. Students will read and be expected to have an in depth understanding of several classic papers from the literature as well as current papers that illustrate cutting edge approaches to systems neuroscience or important new concepts. Use of animals as research model systems will also be discussed. Performance in this portion of the class will be assessed by supplemental exam questions as well as by additional homework assignments.

03-871 Structural Biophysics

Fall: 12 units

The physical properties of biological macromolecules and the methods used to analyze their structure and function are discussed. Topics covered include: protein architecture and folding; nucleic acid structures and energetics; structure determination by X-ray crystallography and NMR; biological spectroscopy with emphasis on absorption, fluorescence, and NMR spectroscopies; other methods to characterize proteins and protein-ligand interactions, such as mass spectrometry, calorimetry, and surface plasmon resonance. Sufficient detail is given to allow the student to critically evaluate the current literature.

Human-Computer Interaction**05-291 HCI for Computer Scientists**

Spring: 12 units

This course introduces the skills and concepts of Human Computer Interaction (HCI) that enable computer scientists to design systems that effectively meet human needs. A concrete illustration of the practice of HCI, this course covers iterative design processes, interactive prototype construction, discount evaluation techniques, and the historical context of HCI. The course is intended for undergraduates and graduate students not majoring in HCI. Students considering a major in HCI should instead take 05-410, Introduction to HCI Methods. The prerequisite for HCI for non-majors is 15-211.

Prerequisites: 15211

05-331 Building Virtual Worlds

Fall: 24 units

This is a project course, where interdisciplinary teams build desktop and immersive (helmet-based) interactive virtual worlds. The course will cover world building, environmental design, non-linear storytelling, and related topics. Students will use 3D Studio Max (CAD modeler), paint tools, such as Adobe PhotoShop and DeepPaint, sound processing tools, and the Alice authoring system (www.alice.org/bvw.htm). Each year, we hold an exhibition in McConomy auditorium to show class projects to the Carnegie Mellon community. The goal of the course is to take students with varying talents, backgrounds, and perspectives and put them together to do what they couldn't do alone. The course is targeted at undergraduates, but grad students may also enroll. To enroll, students must have ONE of the following skills: Modeling with 3D Studio Max Painting using shadow/shape/light in a realistic style; Programming, as evidenced by using the Alice system (www.alice.org); Ability to compose and record original music; Storyboarding Production tracking. The key is that there are no "idea people" in the course; everyone must share in the mechanical creation of the worlds. This is a hands-on course and it takes a lot of time, but most students find it very fulfilling and fun. Note that we don't try to teach artists to program, or engineers to paint; we form teams where everyone does what they're already skilled at to attack a joint project. Class time is roughly split between regular lectures, display/critique of group projects, and guest lectures.

05-395 Applications of Cognitive Science

Spring: 9 units

The famous psychologist George Miller once said that Psychology should "give itself away." The goal of this course is to look at cases where we have done so--or at least tried. The course focuses on applications that are sufficiently advanced as to have made an impact outside of the research field per se. That impact can take the form of a product, a change in practice, or a legal statute. The application should have a theoretical base, as contrasted, say, with pure measurement research as in ergonomics. Examples of applications are virtual reality (in vision, hearing, and touch), cognitive tutors based on models of cognitive processing, phonologically based reading programs, latent semantic analysis applications to writing assessment, and measures of consumers' implicit attitudes. The course will use a case-study approach that considers a set of applications in detail, while building a general understanding of what it means to move research into the applied setting. The questions to be considered include: What makes a body of theoretically based research applicable? What is the pathway from laboratory to practice? What are the barriers-economic, legal, entrenched belief or practice? The format will emphasize analysis and discussion by students.

05-410 Human-Computer Interaction Methods

Fall: 12 units

This course provides an overview and introduction to the field of human-computer interaction (HCI). It introduces students to tools, techniques, and sources of information about HCI and provides a systematic approach to design. The course increases awareness of good and bad design through observation of existing technology, and teaches the basic skills of task analysis, and analytic and empirical evaluation methods. This is a companion course to courses in visual design (51-422) and software implementation (05-430, 05-431). Course is open to undergrads and graduate level non-HCI majors. Sophomores must get permission of the instructor.

05-413 Human Factors

Fall: 9 units

This course uses theory and research from human factors, cognitive science, and social science to understand and design the interactions of humans with the built world, tools, and technology. The course emphasizes current work in applied domains such as automotive design, house construction, medical human factors, and design of information devices. The course also will emphasize not only individual human factors (e.g., visual response, anthropometry) but also the organizational arrangements that can amplify or correct human factors problems. Through reading, discussion, and projects, you will learn about human perceptual, cognitive, and physical processes that affect how people interact with, and use, technology and tools. You will learn why we have so many automobile accidents, voting irregularities, and injuries from prescription medication. You will learn some tried and true solutions for human factors problems, and some of the many problems in human factors that remain. You will also have gained experience in research in this field.

05-417 Computer-mediated Communication

Spring: 12 units

This course examines fundamental aspects of interpersonal communication and considers how different types of computer-mediated communications (CMC) technologies affect communication processes. Among the topics we will consider are: conversational structure and CMC, tools to support nonverbal and paralinguistic aspects of communication such as gesture and eye gaze, and social and cultural dimensions of CMC. Students will be expected to post to weekly discussion lists, to write a paper on a specific aspect of CMC, and to present a talk on their final project to the class. The course should be appropriate for graduate students in all areas and for advanced undergraduates.

05-430 Programming Usable Interfaces

Spring: 12 units

This course is for those with moderate programming skills who want to express their interactive ideas in working prototypes. The course will cover several prototyping tools and require a number of prototypes to be constructed in each. These will range from animated mock-ups through fully functional programs. The course will also cover usability testing of interactive prototypes. Prerequisites: proficiency in a programming language such as C, programming methodology and style, problem analysis, program structure, algorithm analysis, data abstraction, and dynamic data, normally met through an introductory course in programming in C, C++, Pascal or JAVA. Prerequisites: 15100 or 15112 or 15127

05-431 Software Architecture for User Interfaces

Fall: 12 units

This course is intended for those with advanced programming skills who want to do serious development of graphical user interfaces. This course includes: an introduction to task analysis and functional design of the user interface; basic principles of computer graphics used in UI implementation; event handling and event dispatching models; screen update algorithms and multi-view architectures; input syntax formalisms and their transformation into programs; interactive geometry; architectures for advanced features such as cut/copy/paste, macros and groupware. The course is intended for computer science majors. In some cases, the student and the Program Director will jointly determine the choice of 05-430 or 05-431, based upon the student's previous programming experience.

05-432 Cognitive Modeling and Intelligent Tutoring Systems

Fall: 9 units

This course addresses the use of cognitive psychology and cognitive task analysis to create computer-based "intelligent tutoring systems". Students will learn data-driven and theoretical methods for analyzing human problem solving. They will learn about the Cognitive Tutor technology that has been demonstrated to dramatically enhance student learning in domains like mathematics and computer programming. They will learn about methods for assessing robust learning. In addition to discussion and readings on methods and models of problem solving, learning, and tutor design, the course will have a substantial "learning by doing" component. <http://www.cs.cmu.edu/~aleven/teaching/fall2008-05832.html> PREREQUISITES 05-650 or 15-200 or 15-211 or 85-213 or instructor permission. Preferred: 05-410 or a course in AI. Prerequisites: 15211 or 85213 or 85411

05-499 Special Topics in HCII

Intermittent: 9-12 units

05899M "From Smart House to Smart Home:: For many years researchers have been working to operationalize the idea of a smart home. Researchers have made advances to the technical infrastructure including work on context sensing, sensors, and networking. Researchers have also explored issues around user input, designing many different methods of end-user programming for the home. Anthropologists have conducted many studies exploring how people communicate, coordinate their activities, and actively develop and maintain social connections, detailing design implications to inform the products and services people want. Finally, researchers have developed and evaluated a broad range of applications for the smart home that attempt to improve the quality of people's lives. In this class, students will read and discuss different perspectives on what a smart home is, can be, and should be from a variety of perspectives including behavioral science, design, and technology. In addition, students will apply what they have learned by designing and developing an application that transforms a house into a smart home. This course does not require students to have any specific technical background or skills. It is intended for but in no way limited to students with backgrounds in product/interaction design, architecture, anthropology, behavioral science, computer science, or engineering. We are looking for

students with a strong interest in ubiquitous computing and a strong desire to explore how technology can improve people's lives and help to make a home.

05-509 Game Design

Spring: 12 units

05-509 Game Design Spring: 12 units The goal of this course is to prepare students interested in entertainment technology for a career involving design of computer games and other interactive experiences. Students in this course will read and write about game design, and design many games of their own. Do not mistake this for a course in computer game development. This course is focused on the rules and methods of game design, which remain fairly constant regardless of the technology used to develop a game. While technology will play a significant role in our studies, technological details will not be our focus. Students will study and design games of all sorts: card games, dice games, athletic games, story games, and yes, even video games. How to design games, how to design them well, and how to see your designs to completion will be what students master in this course.

05-540 Rapid Prototyping of Computer Systems

Spring: 12 units

This is a project-oriented course, which will deal with all four aspects of project development: the application, the artifact, the computer-aided design environment, and the physical prototyping facilities. The class consists of students from different disciplines who must synthesize and implement a system in a short period of time. Upon completion of this course the student will be able to: generate systems specifications from a perceived need; partition functionality between hardware and software; produce interface specifications for a system composed of numerous subsystems; use computer-aided development tools; fabricate, integrate, and debug a hardware/software system; and evaluate the system in the context of an end user application. The class consists of students from different disciplines who must synthesize and implement a system in a short period of time.

05-571 Undergraduate Project in HCI

Spring: 12 units

Experiential learning is a key component of the MHCI program. Through a substantial team project, students apply classroom knowledge in analysis and evaluation, implementation and design, and develop skills working in multidisciplinary teams. Student teams work with Carnegie Mellon University-based clients or external clients to iteratively design, build and test a software application which people directly use.
Prerequisites: 05410 or 05610 Corequisites: 05-631, 05-431

05-589 Independent Study in HCI-UG

All Semesters: 3-24 units

In collaboration with and with the permission of the professor, undergraduate students may engage in independent project work on any number of research projects sponsored by faculty. Students must complete an Independent Study Proposal, negotiate the number of units to be earned, complete a contract, and present a tangible deliverable. The Undergraduate Program Advisor's signature is required for HCI undergraduate-level Independent Study courses.

05-600 HCI Pro Seminar

Fall: 6 units

Students will attend the one-hour weekly HCII Seminar Series of talks given by national leaders in the field of Human-Computer Interaction. Graduate students will then meet to discuss these topics in a small-group symposium.

Chemical Engineering

06-100 Introduction to Chemical Engineering

Fall and Spring: 12 units

We equip students with creative engineering problem-solving techniques and fundamental chemical engineering material balance skills. Lectures, laboratory experiments, and recitation sessions are designed to provide coordinated training and experience in data analysis, material property estimation for single- and multi-phase systems, basic process flowsheet, reactive and non-reactive mass balances, problem solving strategies and tools, and team dynamics. The course is targeted for CIT First Year students.
Corequisites: 21-120, 09-105

06-200 Sophomore Research Project

Fall and Spring: 3-12 units

Research projects under the direction of the Chemical Engineering faculty. The nature of the project, the number of units, and the criteria for grading are to be determined between the student and

the faculty supervisor. The agreement should then be summarized in a one-page project description for review by the faculty advisor of the student. A final written report or an oral presentation of the results is required.

06-221 Thermodynamics

Fall: 9 units

This course introduces students to the process thermodynamics of single component systems. Topics include equilibrium and thermodynamic state variables; heat and work; conservation of energy and the first law of thermodynamics; entropy balances and the second law of thermodynamics; reversibility; free energies; interconversion of heat and work via engines, refrigeration and power cycles; absolute temperature and the third law of thermodynamics; equations of state; principle of corresponding states; thermodynamic property relationships; changes of state; phase equilibrium and stability in single component systems; vapor pressure and phase transition.
Prerequisites: 06100 and 33106

06-222 Sophomore Chemical Engineering Seminar

Fall: 1 units

This course provides an overview of the chemical engineering profession. It discusses the rationale for the curriculum, career paths, resume writing, written communication skills, and ethics, and also involves a project on the use and manufacture of chemicals.

06-261 Fluid Mechanics

Spring: 9 units

The principles of fluid mechanics as applied to engineering, including unit operations, are discussed; examples include flow in conduits, process equipment, and commercial pipes, flow around submerged objects, and flow measurement. Microscopic mass and momentum balances are described, including the continuity and Navier-Stokes equations, and modern solution techniques will be explored. Microscopic flow structures will be determined for flow visualization. Boundary layer theory, turbulence, and non-Newtonian fluids are also discussed. A case-study project based on new technological advancements is also required.
Prerequisites: 06100 and 21259 Corequisites: 06-262

06-262 Mathematical Methods of Chemical Engineering

Spring: 12 units

Mathematical techniques are presented as tools for modeling and solving engineering problems. Modeling of steady-state mass and energy balance problems using linear and matrix algebra, including Gaussian elimination, decomposition, and iterative techniques. Modeling of unsteady-state engineering problems using linear and nonlinear differential equations. Analytical techniques, including Laplace transforms, and numerical techniques for the solution of first- and higher-order differential equations and systems of differential equations arising in engineering models. Finally, the modeling of processes affected by chance and subject to experimental error; statistical and regression techniques within the context of experimental design and analysis of experimental data.
Prerequisites: 06221 and 21122

06-300 Junior Research Project

Fall and Spring: 3-12 units

Research projects under the direction of the Chemical Engineering faculty. The nature of the project, the number of units, and the criteria for grading are to be determined between the student and the faculty supervisor. The agreement should then be summarized in a one-page project description for review by the faculty advisor of the student. A final written report or an oral presentation of the results is required.

06-321 Chemical Engineering Thermodynamics

Fall: 9 units

The objective of this course is to cover principles and solution techniques for phase and chemical equilibria in multicomponent systems. Topics include thermodynamic properties of ideal and non-ideal mixtures; criteria for equilibrium; chemical potential, fugacity and activity coefficients; flash calculations; Gibbs energy minimization; thermodynamics of chemical reactions including equilibrium conversions.
Prerequisites: 06221

06-322 Junior Chemical Engineering Seminar

Fall: 2 units

This course discusses career choices for chemical engineers, professional practice, including alternate career paths, global industry, and graduate studies. It also emphasizes writing, interview skills, and oral presentations. Safety, environmental and ethical issues are illustrated in projects and via invited lectures.

06-323 Heat and Mass Transfer

Fall: 9 units

This course presents the fundamentals of heat and mass transfer, including steady-state and transient heat conduction and molecular diffusion, convection of heat and mass, and thermal radiation, with application to heat and mass transfer processes. Development of dimensionless quantities for engineering analysis is emphasized.

Prerequisites: 06262 or 21260

06-361 Unit Operations of Chemical Engineering

Spring: 9 units

This course comprises many of the standard operations in chemical plants such as gas absorption, heat exchange, distillation and extraction. The design and operation of these devices is emphasized. A project dealing with a novel unit operation is also investigated.

Prerequisites: 06321 and 06323

06-362 Chemical Engineering Process Control

Spring: 9 units

This course presents basic concepts of process dynamics and feedback control. Included are selection of measurements and manipulated variables, definition of transfer functions, creation of block diagrams and closed loop configurations. The course also covers concepts of open loop and closed loop stability, and tuning of PID controllers.

Prerequisites: 06262

06-363 Transport Process Laboratory

Spring: 6 units

Develop skills for proposing, designing, planning, implementing, interpreting, and communicating the results of experiments in fluid flow and heat and mass transfer. Oral and written reports are required.

Prerequisites: 06261 and 06323

06-400 Senior Research Project

Fall and Spring: 3-36 units

Research projects under the direction of the Chemical Engineering faculty. The nature of the project, the number of units, and the criteria for grading are to be determined between the student and the faculty supervisor. The agreement should then be summarized in a one-page project description for review by the faculty advisor of the student. A final written report or an oral presentation of the results is required.

06-421 Chemical Process Systems Design

Fall: 12 units

Screening of processing alternatives. Computational strategies for preliminary material and energy balances in large chemical processes. Preliminary sizing of process equipment. Cost estimation, economics, and evaluation for chemical plants. Strategies for synthesizing energy networks and separation sequences. Preliminary design of a large industrial project.

Prerequisites: 06321 Corequisites: 06-422

06-422 Chemical Reaction Engineering

Fall: 9 units

Fundamental concepts in the kinetic modeling of chemical reactions, the treatment and analysis of rate data. Multiple reactions and reaction mechanisms. Analysis and design of ideal and non-ideal reactor systems. Energy effects and mass transfer in reactor systems. Introductory principles in heterogeneous catalysis.

Prerequisites: 09347

06-423 Unit Operations Laboratory

Fall: 9 units

Open-ended laboratory projects illustrate the principles of unit operations in Chemical Engineering. In this course students select, with course staff review, current societal problems to which chemical engineering subject knowledge can be applied. Students work in teams to design and implement an experimental plan to evaluate proposed solutions. Teams must work together to identify constraints and relationships between the unit operations they work on. Students must document implementation feasibility (cost, scheduling, analytic capability, etc.) and clearly identify the criteria and methods for assessing experimental results. Oral and written reports are required.

Prerequisites: 06361 and 06362

06-426 Experimental Colloid Surface Science

Fall: 9 units

Laboratory exercises will deal with preparation and stabilization of colloids, flocculation, micellar aggregates, surface tension, contact angle, spreading and adsorption. Basic concepts will be related to practical problems of wetting, lubrication, foaming, adhesion, coatings and corrosion.

Prerequisites: 06607 and 09221

06-462 Optimization Modeling and Algorithms

Spring: Mini Session - 6 units

Formulation and solution of mathematical optimization problems with and without constraints. Objective functions are based on economics or functional specifications. Both discrete and continuous variables are considered.

Prerequisites: 06421

06-463 Chemical Product Design

Spring: Mini Session - 6 units

Computer-aided design of a chemical product. Course involves design of molecular structure, microstructure, or devices/processes that effect chemical change. This is a project-based course, for which an extensive report must be submitted.

Prerequisites: 06421 Corequisites: 06-462

06-466 Experimental Polymer Science

Spring: 9 units

Macromolecular behavior in bulk and in solution will be explored in experiments on tensile strength, elasticity, swelling of networks, solution viscosity, melt flow, and polymerization reactions. Particular reference will be made to aspects affecting production and fabrication of polymeric materials.

Prerequisites: 09221 and (06609 or 09509)

06-606 Computational Methods for Large Scale Process Design & Analysis

Spring: 9 units

This course deals with the underlying computer-aided design techniques for steady-state and dynamic simulation, numerical solution and decomposition strategies for large systems of sparse nonlinear algebraic equations, stiff ordinary differential equations, strategies for mixed algebraic/differential systems and computer architectures for flowsheeting systems.

Prerequisites: 06262 and 06361

06-607 Physical Chemistry of Colloids and Surfaces

All Semesters: 9 units

Thermodynamics of surfaces; adsorption at gas, liquid, and solid interfaces; capillarity; wetting, spreading, lubrication and adhesion; properties of monolayers and thin films; preparation and characterization of colloids; colloidal stability, flocculation kinetics, micelles, electrokinetic phenomena and emulsions.

Prerequisites: 06221 and 09347

06-608 Safety Issues in Science and Engineering Practice

Fall: 3 units

Exposes the students to personal safety issues encountered in normal science and engineering practice. Topics covered include mechanical, electrical, chemical, radiation, and biological hazards, to provide an awareness of these hazards and appropriate action to be taken in the event of an accident.

06-609 Physical Chemistry of Macromolecules

Fall: 9 units

This course develops fundamental principles of polymer science. Emphasis is placed on physio-chemical concepts associated with the macromolecular nature of polymeric materials. Engineering aspects of the physical, mechanical and chemical properties of these materials are discussed in relation to molecular structure. Topics include an introduction to polymer science and a general discussion of commercially important polymers; molecular weight; condensation and addition synthesis mechanisms with emphasis on molecular weight distribution; solution thermodynamics and molecular conformation; rubber elasticity; and the rheological and mechanical properties of polymeric systems. Students not having the prerequisite listed may seek permission of the instructor.

Prerequisites: 09347

06-610 Rheology and Structure of Complex Fluids

Fall: 9 units

This course will cover the basic concepts of rheology and mechanical behavior of fluid systems. Both the experimental and theoretical aspects of rheology will be discussed. The basic forces influencing complex fluid rheology and rheology will be outlined and discussed;

including excluded volume, van der Waals, electrostatic and other interactions. Methods of characterizing structure will be covered including scattering techniques, optical polarimetry and microscopy. Examples will focus on several types of complex fluids including polymer solutions and melts, gelling systems, suspensions and self-assembling fluids.

Prerequisites: 06609 or 09509

06-619 Semiconductor Processing Technology

Spring: 9 units

This is an introductory course to the physical and chemical concepts involved in integrated circuit processing. The material focuses on basic principles in chemical reaction engineering and how they can be applied to integrated circuit process engineering. Students not having the prerequisites listed may seek permission of the instructor.

Prerequisites: 06422 and 09347

06-620 Global Atmospheric Chemistry: Fundamentals and Data Analysis Methods

Spring: 9 units

This course will explore global atmospheric chemistry through a series of case studies: Stratospheric Ozone, Global Methane and OH, and Urban and Regional Ozone. Each case will begin with a description of the chemistry and atmospheric physics fundamental to the particular problem. Students will formulate testable mathematical models incorporating that chemistry and physics, turning then to existing atmospheric data sets to test current understanding. The emphasis of this course is to develop an understanding of how to pose a testable hypotheses in a complex chemical environment such as the atmosphere, validate or refute those hypotheses, and then by extension predict how the system will respond to perturbations. A particular objective is to explore how to extend this methodology from the stratosphere and background troposphere (the first two cases), where it has been applied with success, to the much more complicated problem of urban and regional air quality. Students not having the prerequisites listed may seek permission of the instructor.

Prerequisites: 06262 and 09105

06-621 Biotechnology and Environmental Processes

Fall: 9 units

First half of the course: microbial physiology and metabolism, fermentations and respiration, metabolic regulation, bioconversions, recombinant DNA methodology and gene cloning. Second half: separation and purification, kinetics and design of biological reactors, mass transfer limitations within cell suspensions, and control of fermentation processes. Lectures will cover aspects of accuracy and resolution, relative merits and limitations, selection criteria, and typical practical applications for these devices. Several laboratory demonstrations will be provided. Each student will be expected to submit a project report on a topic assigned in the beginning of the course.

Prerequisites: 03231 or 03232

06-622 Bioprocess Design

Fall and Spring: 9 units

This course is designed to link concepts of cell culture, bioseparations, formulation and delivery together for the commercial production and use of biologically-based pharmaceuticals; products considered include proteins, nucleic acids, and fermentation-derived fine chemicals. Associated regulatory issues and biotech industry case studies are also included. A fair knowledge of cell culture and fermentation operations is assumed.

Prerequisites: 06621 or 42621

06-630 Atmospheric Chemistry, Air Pollution and Global Change

Fall and Spring: 12 units

Principles necessary to understand the atmospheric behavior of air pollutants in urban, regional, and global scales are the subjects of this course. Key topics include atmospheric gas-, aqueous-, and aerosol-phase chemistry; removal processes and residence times; aerosol physics; pollutant effects on visibility and the energy balance of the planet; mathematical modeling of air pollution. The student finishing the course will understand the fundamentals of atmospheric chemistry and physics and their relationship to urban, regional, and global pollution problems. Students not having the prerequisites listed may seek permission of the instructor.

Prerequisites: 06262 and 09105

06-640 Principles and Applications of Molecular Simulation

Fall and Spring: 9 units

This course will introduce modern concepts and methods for simulating physical and thermodynamics properties of materials from atomic-scales, with special emphasis on the gas and liquid states. Strengths and limitations of molecular simulation methods will be

discussed. Topics will include basic statistical mechanics, interatomic potentials, Molecular Dynamics methods, Monte Carlo methods, computation of phase coexistence curves, and Brownian Dynamics.

Prerequisites: 06262 and 06321

Institute for Software Research

08-463 Service Innovation

Spring: Mini Session - 6 units

This course introduces students to the concept of services and their increasing role in the global economy and global employment, and explores services as a part of a goods-services continuum ranging from products or goods to service encapsulation of products to pure services. Service innovation is defined, and contrasts drawn between service and product innovation. Service innovation mechanisms and barriers to innovation are explored, as are organizational outcomes and measurement of service innovation. Course discussion identifies selected issues in service innovation, such as the innovation value chain, co-creation of service innovations, service innovation for sustainability, innovation in public service, changes in employment, globalization of service innovation, service design, or the ethics of service innovation; and assesses the impact of these on future service innovation agendas.

08-533 Privacy, Policy, Law and Technology

Fall: 9 units

As new technologies are developed, they increasingly raise privacy concerns-the Web, wireless location-based services, and RFID are a few examples. In addition, the recent focus on fighting terrorism has brought with it new concerns about governmental intrusions on personal privacy. This course provides an indepth look into privacy, privacy laws, and privacy-related technologies. Students will study privacy from philosophical, historical, legal, policy, and technical perspectives and learn how to engineer systems for privacy. This course is appropriate for graduate students, juniors, and seniors who have strong technical backgrounds. 8-733 is for PhD students. 8-533 and 19-608 are for undergraduate students. Masters students may register for any of the course numbers. This course will include a lot of reading, writing, and class discussion. Students will be able to tailor their assignments to their skills and interests, focusing more on programming or writing papers as they see fit. However, all students will be expected to do some writing and some technical work. A large emphasis will be placed on research and communication skills, which will be taught throughout the course.

08-733 Privacy, Policy, Law and Technology

Fall: 12 units

As new technologies are developed, they increasingly raise privacy concerns-the Web, wireless location-based services, and RFID are a few examples. In addition, the recent focus on fighting terrorism has brought with it new concerns about governmental intrusions on personal privacy. This course provides an indepth look into privacy, privacy laws, and privacy-related technologies. Students will study privacy from philosophical, historical, legal, policy, and technical perspectives and learn how to engineer systems for privacy. This course is appropriate for graduate students, juniors, and seniors who have strong technical backgrounds. 8-733 is for PhD students. 8-533 and 19-608 are for undergraduate students. Masters students may register for any of the course numbers. This course will include a lot of reading, writing, and class discussion. Students will be able to tailor their assignments to their skills and interests, focusing more on programming or writing papers as they see fit. However, all students will be expected to do some writing and some technical work. A large emphasis will be placed on research and communication skills, which will be taught throughout the course.

Chemistry

09-101 Introduction to Experimental Chemistry

Fall and Spring: Mini Session - 3 units

This is a seven week chemistry laboratory course that is designed to introduce students to some basic laboratory skills, techniques, and equipment commonly used in experimental chemical investigations. The experiments will apply concepts in organic synthesis, quantitative analysis using visible spectrophotometry, kinetics, acid-base chemistry, thermochemistry, transition metal chemistry, chromatography, and protein biochemistry. 1 hr. lec., 3 hrs. lab.

09-102 Special Topics

Spring: Mini Session - 3 units

A selection of mini-courses offered to introduce first-year students to special topics in modern chemistry. The courses meet for half a semester and may include some hands-on laboratory and computer

experiences. Topics vary, but have included: Forensic Chemistry in the Criminal Justice System, Macromolecules for Nanotechnology, Popularization of Science Through Books, Plays and Film, Kaboom and Other Approaches to Teaching Science, Dating Using Radioactivity and Computer Molecular Modeling. Enrollment limited to first-year MCS and SHS students.

09-103 Atoms, Molecules and Chemical Change
Fall: 9 units

This is a one-semester introductory college level course designed for non-science majors who have had a high school course in chemistry. Chemistry topics will be introduced on an as needed basis in the contexts of air pollution, the ozone layer, global warming, acid rain, safe drinking water, alternative energy sources, plastics, and drug design. Students will apply concepts in topics such as the classification of matter, the relationship between matter and energy, atomic theory and the Periodic Table, chemical bonding, molecular shapes, molecular polarity, interparticle forces, chemical reactions, stoichiometry, properties of aqueous solutions, acid-base chemistry, redox chemistry, and organic chemistry. Students will gain an understanding of how chemistry impacts major environmental, social, political, and economic issues that we encounter daily. They will also learn to apply chemical concepts to new situations or contexts. 3 hrs. lec., 1 hr. rec.

09-104 Fundamental Aspects of Organic Chemistry and Biochemistry
Spring: 9 units

This course, which includes demonstrations and "hands-on" activities, is designed to engage non-majors in the fascination of chemistry. It is not essential that a student has completed 09-103 in order to take this course. The lecture part of this course will include wide ranging science topics designed to put the world of chemistry in perspective. After achieving a competency in fundamentals we proceed to systematically survey the important topics of synthesis, structure and mechanism in organic chemistry. With these insights we finally confront the important biological molecules including DNA. 3 hrs lec., 1 hr rec.

09-105 Introduction to Modern Chemistry I
Fall and Spring: 10 units

This course begins with a very brief survey of some fundamental principles of chemistry and a presentation of chemically interesting applications and sophisticated problems. These will form the basis for introducing the relationships between the structure of molecules and their chemical properties and behavior. The subject matter will include principles of atomic structure, chemical bonding, intermolecular interactions and molecular structures of organic and inorganic compounds including some transition metal complexes. Relevant examples will be drawn from such areas as environmental, materials, and biological chemistry. 3 hrs. lec, 2 hrs. rec.

09-106 Modern Chemistry II
Fall and Spring: 10 units

This course provides an overview of thermodynamics, kinetics and chemical equilibrium. Topics include the flow of energy in chemical systems; the spontaneity of chemical processes, i.e. entropy and free energy; the mechanisms and rates of chemical reactions; and the use of chemical equilibrium to reason about acid-base chemistry, solubility and electrochemistry. Applications include the energy economy, biological systems and environmental chemistry. 3 hrs. lec., 2 hrs. rec.
Prerequisites: 09105 or 09107

09-107 Honors Chemistry: Fundamentals Concepts and Applications
Fall: 10 units

Honors Chemistry is an introductory course that teaches the foundations of Modern Chemistry and applies them to current scientific issues, such as Green Chemistry, Biotechnology and Materials Science. Topics include modern theories of bonding, organization of atoms, molecular interactions, biochemistry and transition metal chemistry. Enrollment is limited to first-year students, with priority given to those in MCS. 3 hrs. lec., 2 hrs. rec.

09-201 Undergraduate Seminar I
Fall: 1 units

Issues and topics of importance to beginning chemistry majors are discussed in this course. It provides a general introduction to the facilities, faculty and programs of the Department of Chemistry and introduces students to career and research opportunities in the field of chemistry. Enrollment limited to students majoring in chemistry. 1 hr.

09-202 Undergraduate Seminar II

Spring: 1 units

Issues and topics focused on laboratory safety are discussed in this class. The topics are selected to supplement information covered in 09-221, Laboratory I. This course is intended to provide the necessary safety training for students wishing to undertake undergraduate research projects in the laboratory and is taught in collaboration with the Office of Environmental Health and Safety. Enrollment is limited to chemistry majors. 1 hr.

09-204 Professional Communication Skills in Chemistry
Spring: 3 units

This required course for chemistry majors only promotes development of written and oral communication skills in various formats within the discipline. Students are expected to develop these skills by becoming more familiar with: the style and format of the chemical literature, current topics in chemistry, and research projects in the Department. Other learning outcomes include developing critical reading skills, providing effective feedback to peers' written and oral communication, demonstrating the ability to revise written work, and using chemical structure drawing software. 1 hr. lec.

09-214 Physical Chemistry
Spring: 9 units

This is a one-semester course intended primarily for students majoring in Biological Sciences, students pursuing a B.A. degree program in Chemistry, and students in the B.S.A. program with a concentration in chemistry. The course focuses on thermodynamics, transport and reaction rates and their application to chemical and biological systems. Emphasis is given to attaining a good fundamental understanding of entropy and free energy. This is more a concepts than skills building course. Topics include applications of thermodynamics to chemical and biochemical equilibria, electrochemistry, solutions, and chemical kinetics. 3 hrs. lec.
Prerequisites: 09106 and 21118 and 33111 and (09105 or 09107)

09-217 Organic Chemistry I
Fall: 9 units

This course presents an overview of structure and bonding as it pertains to organic molecules. Selected topics include: introduction to functional group chemistry, stereochemistry, conformational analysis, reaction mechanisms and use of retrosynthetic analysis in the development of multistep syntheses. Methods for structure determination of organic compounds by modern spectroscopic techniques are introduced. 3 hrs. lec., 1 hr. rec.
Prerequisites: 09105 or 09107

09-218 Organic Chemistry II
Spring: 9 units

This course further develops many of the concepts introduced in Organic Chemistry I, 09-217. Emphasis is placed on the utilization of reaction mechanisms for understanding the outcome of chemical transformations, and the employment of a wide variety of functional groups and reaction types in the synthesis of organic molecules. Also included in the course will be special topics selected from the following: polymers and advanced materials, biomolecules such as carbohydrates, proteins and nucleic acids, and drug design. 3 hrs. lec., 1 hr. rec.
Prerequisites: 09217 or 09219

09-219 Modern Organic Chemistry
Fall: 10 units

Traditional introductory organic chemistry courses present structure, reactivity, mechanisms and synthesis of organic compounds. Students taking 09-219 will be exposed to the same topics, but presented in greater depth and broader context, with applications to allied fields such as (1) polymer and materials science and (2) biological sciences and medicine. This will be accomplished through an extra 50 minute lecture period, where more advanced topics and applications will be discussed. Topics will include computational chemistry, green chemistry, chiral separations, photochemistry, reaction kinetics, controlled radical polymerizations and petroleum cracking. Students who complete 09-219 will have a strong foundation in organic chemistry as well as a sophisticated understanding of how organic chemistry is currently practiced and applied to the most urgent problems facing society.
Prerequisites: 09105 or 09107

09-220 Modern Organic II
Spring: 10 units

This course builds on 09-219 by introducing students to additional functional groups, chemical reaction mechanisms and synthetic strategies commonly used in the practice of organic chemistry. Advanced topics to be presented during the extra lecture will include multidimensional NMR spectroscopy, enantioselective synthesis,

ionic polymerization, bioorganic and medicinal chemistry, natural products chemistry and toxicology. Students who complete 09-220 will have a strong foundation in synthetic, mechanistic and structural organic chemistry and will understand how this applies to human health and the environment.
Prerequisites: 09219

09-221 Laboratory I: Introduction to Chemical Analysis
Fall and Spring: 12 units

This course is the first in a sequence of four laboratory courses on experimental aspects of chemistry. The experimental work emphasizes the techniques of quantitative chemical analysis. Included are projects dealing with a variety of instrumental and wet chemical techniques. The course is project-oriented with the experiments becoming more complex, requiring greater student input into the experimental design as the semester progresses. A mixture of individual and team experiments are conducted during the semester. In addition to techniques, safety, written and oral communication skills, and effective teamwork are emphasized. 2 hrs. lec., 6 hrs. lab.
Prerequisites: 09106

09-222 Laboratory II: Organic Synthesis and Analysis
Fall and Spring: 12 units

In this second course in the laboratory sequence, students acquire laboratory skills relevant to synthesis and purification of organic compounds, as well as the practical use of chromatography and spectroscopy. Students will also further develop technical writing skills through preparation of lab reports. 2 hrs. lec., 6 hrs. lab.
Prerequisites: (09217 or 09219) and 09221

09-231 Mathematical Methods for Chemists
Fall: 9 units

This course covers mathematical techniques that are important in the chemical sciences. The techniques will be covered in the context of chemical phenomena, and combine topics from 3-dimensional calculus, differential equations, linear algebra and statistics. This course does not count towards the minor in chemistry. 3 hrs. lec.
Prerequisites: 09106 and (21122 or 21123)

09-301 Undergraduate Seminar III
Fall: 1 units

Students attend seminars on current topics in chemistry. Students are sent a menu of choices for each week of the semester and may select topics of interest. Enrollment is restricted to students majoring in chemistry. 1 hr.

09-302 Undergraduate Seminar IV
Spring: 1 units

Students attend seminars presented by senior chemistry majors. Presentations are evaluated and students become familiar with special topics in chemistry. Some pointers on how to organize and present an effective seminar on a topic in chemistry are given. The courses establish what should be included in a good seminar. These seminar courses are required for chemistry majors. If a schedule conflict exists, students may, with permission of the instructor, attend other chemistry seminars or make other arrangements to fulfill the requirement. 1 hr.

09-321 Laboratory III: Molecular Design and Synthesis
Fall: 12 units

In this third course in the laboratory sequence, students will learn a variety of more advanced techniques for organic synthesis and characterization, and will gain experience with developing and designing synthetic procedures. Student writing skills are further reinforced through preparation of detailed lab reports. 2 hrs. lec., 6 hrs. lab.
Prerequisites: (09218 or 09220) and 09222

09-322 Laboratory IV: Molecular Spectroscopy and Dynamics
Spring: 12 units

This laboratory course is devoted to physical chemistry experiments, which involve the use of modern spectroscopic instrumentation to probe the optical and magnetic properties of molecules. The experiments include the use of high-resolution infrared, laser Raman, NMR, EPR, fluorescence, and UV-visible spectroscopies. Additional experiments demonstrate methods for measuring enzyme-catalyzed reaction rate constants, and the use of scanning probe microscopy for imaging and characterization of biological macromolecules. Throughout the course the students will learn how to use computer algebra packages for rigorous data analysis and modeling and will develop the skills in basic electronics, and vacuum techniques. 2 hrs. lec., 6 hrs. lab.
Prerequisites: 09221 and 09331 and 09344 Corequisites: 09-345

09-331 Modern Analytical Instrumentation
Fall: 9 units

This course will cover all aspects of analytical instrumentation and its application to problems in materials, environmental, and biological chemistry. Topics covered will include mass spectrometry, optical spectroscopies and NMR. In addition, the course will emphasize how to select an analytical method appropriate to the problem at hand, how to optimize the signal to noise obtained by a measurement, and the quantitative analysis of experimental data. Some basic electronics will be covered as well. 3 hrs. lec.
Prerequisites: 09221 and 09222 Corequisites: 09-344

09-341 The Art and Science of Color
Intermittent: 9 units

The color of minerals is a property easily noticeable by the expert and the casual viewer alike, and has made minerals attractive to people for millennia. Artists have made use of minerals to create inorganic pigments which formed the bulk of the artistic palette until the industrial revolution. Historically, the craft of painting was closely linked to the practice of pigment manufacture, with painters procuring their materials in raw form directly from the chemist/apothecary, and often performing the final purification and grinding of the minerals into pigments. With the advent of mass-produced and marketed art materials in the nineteenth century, the distance between chemist and artist increased until the two worlds have little to do with one another. The class aims to reconnect the two disciplines for a study of their common ground: particularly the color of minerals. This color is underscored by inorganic chemistry, which governs the formation and properties of minerals. Students learn about the origin of the color of minerals with primary focus on colors that originate from electronic transitions and apply knowledge of the electronic structure of transition metal ions to analyze and interpret the color. Students work collaboratively with Art students on hands-on laboratory research projects that involve the synthesis, characterization, and use of inorganic pigments. Students interact with the scientists of the Hillman Hall of Minerals and Gems of the Carnegie Museum of Natural History and of the Artist's Materials Center of Carnegie Mellon. A series of researchers who work at the boundary between art and chemistry will give guest lectures. This is a project course open to majors in chemistry and art. The course and its projects are designed to expand the expertise of students in both disciplines, while exposing them to the methods, demands and aims of the other. 2 hrs. lec, 1 hr. rec., 3 hrs lab
Prerequisites: 09348 and 09221

09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry
Fall: 9 units

The measurement and theoretical description of the properties of atoms and molecules are presented. The elementary principles of quantum chemistry are developed. The many types of spectroscopy used to study atoms and molecules are described. Methods of atomic structure determination are discussed. The structure and properties of solids are also presented. The basic results of statistical chemistry are outlined and a brief connection to thermodynamics is made. 3 hrs. lec., 1 hr. rec.
Prerequisites: (09105 or 09107) and (21259 or 09231)

09-345 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry
Spring: 9 units

The measurement and theoretical descriptions of the equilibrium properties of chemical systems are presented. Chemical thermodynamics is introduced at the upper division level. The phases of matter are discussed. The quantitative treatment of mixtures is developed. The detailed description of chemical equilibrium is elaborated. The measurement and theoretical description of the nonequilibrium properties of chemical systems are presented. Elementary transport properties are introduced. The principles of classical chemical kinetics are developed in great detail. 3 hrs. lec., 1 hr. rec.
Prerequisites: 09106 and (21259 or 09231)

09-347 Advanced Physical Chemistry
Fall: 12 units

A course of study designed to provide the microscopic basis of concepts encountered in the field of chemical engineering. The properties of macroscopic materials are calculated in terms of the microscopic properties of atoms and molecules. Both classical and quantum approaches are employed. The thermodynamic properties are developed in terms of the chemical potentials of the constituent particles. The transport properties are calculated using molecular dynamics and Brownian dynamics. Classical chemical kinetics is fully developed and applied to complex reactions. Rate constants are calculated for simple reactions in gases and solutions. The course is

limited to chemical engineering majors. 5 hrs. lec.
Prerequisites: (06151 or 06221) AND (06155 or 06262) AND (09105 or 09107)

09-348 Inorganic Chemistry

Spring: 10 units

The focus of this class is understanding the properties of the elements and of the inorganic compounds. The electronic structure of elements is discussed as the basis for the element's organization in the Periodic Table and for their properties. The systematic chemistry of main group elements and of transition metals is presented. The number of inorganic compounds is extremely large and their properties are extremely diverse. Therefore in this course, the presentation of physical and chemical properties of inorganic compounds is based upon the observation of the trends in the respective properties and the relation between these trends and the place of the elements in the Periodic Table. 3 hrs. lec., 1 hr. rec.
Prerequisites: 09106

09-401 Undergraduate Seminar V

Fall: 1 units

Students attend seminars on current topics in chemistry. Students are sent a menu of choices for each week of the semester and may select topics of interest. Enrollment is restricted to students majoring in chemistry. 1 hr.

09-402 Undergraduate Seminar VI

Fall and Spring: 3 units

Students enrolled in this course present a 20 - 30 minute oral report on a current topic in chemistry. This may be from the student's research work or a special chemistry topic of general interest. Presentations or papers prepared for other courses are not acceptable. Thoroughness in the use of the chemical literature is emphasized. The use of presentation aids such as PowerPoint is encouraged. Other students in the class submit written evaluations of the presentation. A seminar presentation is required of all chemistry majors. No exceptions possible. Enrollment is limited to students majoring in chemistry. 1 hr.

09-435 Independent Study Chemistry

All Semesters: 1.0 - 12.0 units

The course allows students to earn academic credit for concentrated study in a topic area developed in conjunction with and monitored by a faculty member in the Department of Chemistry. These topics are distinct from projects that would rise to the level of undergraduate research either because they are in unrelated areas distinct from the faculty member's research interests or may constitute the investigation and compilation of existing information from a variety of resources and may not be expected to result in the generation of new information as is a reasonable expected outcome in undergraduate research (likely is not publishable).

09-445 Undergraduate Research

Fall and Spring: 3-18 units

Properly qualified students may undertake research projects under the direction of members of the faculty, normally 6 to 12 hrs/week. A written, detailed report describing the project and results is required. Course may be taken only with the consent of a faculty research advisor in chemistry or on occasion in another department provided that the project is chemical in nature and with permission of the Director of Undergraduate Studies. The number of units taken generally corresponds to the actual number of hours the student actually spends in the lab doing research during the week. Maximum number of units taken per semester is 18.

09-455 Honors Thesis

Fall and Spring: 6,15 units

Students enrolled in the departmental honors program are required to enroll in this course to complete the honors degree requirements. A thesis written in an acceptable style describing an original research project, and a successful oral defense of the thesis topic before an Honors Committee are required. Limited to students accepted into the honors program. (B.S. Honors candidates normally enroll for 6 units; B.S./M.S. candidates enroll for 15 units.)

09-502 Organic Polymer Chemistry

Spring: 9 units

A study of the synthesis and reactions of high polymers. Emphasis is on practical polymer preparation and on the fundamental kinetics and mechanisms of polymerization reactions. Topics include: relationship of synthesis and structure, step-growth polymerization, chain-growth polymerization via radical, ionic and coordination intermediates, copolymerization, discussions of specialty polymers and reactions of polymers. (Graduate Course: 12 units, 09-741)
Prerequisites: 09218 or 09220

09-507 Nanoparticles

Intermittent: 9 units

This course discusses the chemistry, physics, and biology aspects of several major types of nanoparticles, including metal, semiconductor, magnetic, carbon, and polymer nanostructures. For each type of nanoparticles, we select pedagogical examples (e.g. Au, Ag, CdSe, etc.) and introduce their synthetic methods, physical and chemical properties, self assembly, and various applications. Apart from the nanoparticle materials, other topics to be briefly covered include microscopy and spectroscopy techniques for nanoparticle characterization, and nanolithography techniques for fabricating nano-arrays. The course is primarily descriptive with a focus on understanding major concepts (such as plasmon, exciton, polaron, etc.). The lectures are power point presentation style with sufficient graphical materials to aid students to better understand the course materials. Overall, this course is intended to provide an introduction to the new frontiers of nanoscience and nanotechnology. Students will gain an understanding of the important concepts and research themes of nanoscience and nanotechnology, and develop their abilities to pursue highly disciplinary nanoscience research. The course should be of interest and accessible to advanced undergraduates and graduate students in fields of chemistry, materials science, and biology.

09-509 Physical Chemistry of Macromolecules

Fall: 9 units

This course develops fundamental principles of polymer science. Emphasis is placed on physio-chemical concepts associated with the macromolecular nature of polymeric materials. Engineering aspects of the physical, mechanical and chemical properties of these materials are discussed in relation to chain microstructure. Topics include an introduction to polymer science and a general discussion of commercially important polymers; molecular weight; condensation and addition synthesis mechanisms with emphasis on molecular weight distribution; solution thermodynamics and molecular conformation; rubber elasticity; and the rheological and mechanical properties of polymeric systems. (This course is also listed as 06-609. Graduate Course: 12 units, 09-715) 3 hrs. lec.
Prerequisites: 09345 or 09347

09-510 Introduction to Green Chemistry

Spring: 9 units

The new field of Green chemistry focuses upon the reduction and elimination of hazards from chemical products and processes. Sustainability ethics will be introduced and discussed--these are central to all sustainability related education. The "principles of green chemistry" will be presented and analyzed. The chemical nature and action of certain pollutants of the atmosphere, land, and water, will be highlighted along with prospects for their minimization, and approaches for their eradication. Particular attention will be paid to sources of and potential replacements for persistent bioaccumulative pollutants. A historical and technical analysis of costs to society of hazards and bad management practices associated with the lead and chlorine industries will be presented in detail. The recently discovered mechanism of toxicity called "endocrine disruption" will be introduced and its vast implications for the design of chemical products and processes will be explored: a resulting concept is that chemists need to learn how to protect the health of babies in the design and development of chemical products and processes as a critical element of developing the technological dimension of a sustainable civilization. A new platform oxidation technology with potential to reduce toxic effluents in multiple industrial sectors will be examined by students in a laboratory setting: this technology has been invented at Carnegie Mellon. A significant effort has been made by the instructor to produce a course suitable for an interdisciplinary audience. This course is recommended for students in the junior and senior year. (Graduate Course: 12 units, 09-710)
Prerequisites: (09218 or 09220) and 09348

09-517 Organotransition Metal Chemistry

Fall: 9 units

The first half of this course focuses on the fundamentals of structure and bonding in organotransition metal complexes and how the results can be used to explain, and predict, chemical reactivity. The latter half of the course covers applications, and more specifically, homogeneous catalysts for industrial processes and organic synthesis. (Graduate Course: 12 units, 09-717)
Prerequisites: 09348

09-518 Bioorganic Chemistry: Nucleic Acids and Carbohydrates

Fall: 9 units

This course will introduce students to new developments in chemistry and biology, with emphasis on the synthesis, structural and functional aspects of nucleic acids and carbohydrates, and their applications in chemistry, biology and medicine. Later in the course,

students will have the opportunity to explore cutting-edge research in this exciting new field that bridges chemistry with biology. Students will be required to keep abreast of the current literature. In addition to standard homework assignments and examinations, students will have the opportunity to work in teams to tackle contemporary problems at the forefront of chemistry and biology. The difference between the 09-518 (9-unit) and 09-718 (12-unit) is that the latter is a graduate level course. Students signed up for 09-718 will be required to turn in an original research proposal at the end of the course, in addition to all the other assignments. (Graduate Course: 12 units, 09-718) 3 hrs. lec.
Prerequisites: 09218 or 09220

09-519 Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry
Spring: 9 units

This course will introduce students to new developments in chemistry and biology, with emphasis on the synthesis, structural and functional aspects of peptides, proteins and small molecules. Basic concepts of bioorganic chemistry will be presented in the context of the current literature and students will have the opportunity to learn about the experimental methods used in various research labs. An introduction to combinatorial chemistry in the context of drug design and drug discovery will also be presented. Students will be required to keep abreast of the current literature. Homeworks and team projects will be assigned on a regular basis. The homework assignments will require data interpretation and experimental design; and team projects will give students the opportunity to work in teams to tackle contemporary problems at the interface of chemistry and biology. Students enrolled in the graduate level course (09-719) will be required to turn in an original research proposal at the end of the course, in addition to the homework assignments, midterm, and final exam that are required for the undergraduate course. (Graduate Course: 12 units 09-719) 3 hrs. lec.
Prerequisites: 09218 or 09220

09-520 Global Atmospheric Chemistry: Fundamentals and Data Analysis Methods
Intermittent: 9 units

This course will explore global atmospheric chemistry through a series of case studies: Stratospheric Ozone, Global Methane and OH, and Urban and Regional Ozone. Each case will begin with a description of the chemistry and atmospheric physics fundamental to the particular problem. Students will formulate testable mathematical models incorporating that chemistry and physics, turning then to existing atmospheric data sets to test current understanding. The emphasis of this course is to develop an understanding of how to pose a testable hypotheses in a complex chemical environment such as the atmosphere, validate or refute those hypotheses, and then by extension predict how the system will respond to perturbations. A particular objective is to explore how to extend this methodology from the stratosphere and background troposphere (the first two cases), where it has been applied with success, to the much more complicated problem of urban and regional air quality. (This course is also listed as 06-620.)
Prerequisites: 21260 or 09231 Corequisites: 09-347, 09-344

09-521 Bioinorganic Chemistry
Intermittent: 9 units

The course addresses the basis for the selection and regulation of metal atoms and ligand systems and their interactions with their corresponding protein environments. The chemistry of catalytic processes in metalloenzymes, and atom transfer and electron transport in metalloproteins will be reviewed. The array of physical methods required for study will be introduced, with application toward the determination of electronic and molecule structure and enzymatic mechanisms. (Graduate Course: 12 units, 09-721)
Prerequisites: 09344 and 09348

09-522 Oxidation and Inorganic Chemistry
Intermittent: 9 units

The roles of metal complexes in chemical and biochemical oxidations will be presented. Special attention is given to processes involving the activation of molecular oxygen and hydrogen peroxide by metal complexes and metalloenzymes from a mechanistic viewpoint. Much attention is devoted to kinetic methods of investigation of homogeneous reactions and mechanisms of oxidative catalysis. Redox properties and electronic structures of metal complexes will be reviewed. The relationships between electronic structures, catalytic properties, and oxidation reactivity of biologically relevant metal complexes will be provided. Mechanistic pathways of oxidation by peroxidases, cytochrome P-450, and other metalloenzymes will be described. (Graduate Course: 12 units, 09-722)
Prerequisites: 09348

09-525 Transition Metal Chemistry

Intermittent: 9 units
This class covers fundamental concepts in Transition Metal Chemistry, including coordination numbers and stereochemistry, electronic structure, physical properties, and aspects of chemical reactivity of transition elements and their complexes. Point group theory is used to link the geometric and electronic structures of high symmetry coordination compounds. Analysis of the electronic structure of low symmetry coordination complexes is based on the Angular Overlap Model. In choosing coordination complexes that are discussed in class, special emphasis is given to those that are relevant for the fields of research of students enrolled in the class, such as supramolecular chemistry, nanotechnology, and metal-based catalysis. Students learn about the choice and relevance of modern questions posed by researchers in these fields and the modern methods and techniques used to answer the questions. Students learn also in this course how to use the Cambridge Crystallographic Database, a repository of structural data for more than 200,000 compounds, and how to use Mathematica to solve chemical problems. No prior knowledge of this software is required. (Graduate Course: 12 units, 09-725) 3 hrs. lec.
Prerequisites: 09348

09-543 Mass Spectrometry: Fundamentals, Instrumentation and Techniques

Intermittent: Mini Session - 6 units
This course is intended for students interested in understanding fundamentals, instrumentation and techniques used in mass spectrometry (MS). The operating principles of various ion sources (EI, CI, ESI and MALDI), mass analyzers (magnetic, quadrupole, time-of-flight, ion traps) and detectors are covered. Applications are focused in the areas of small molecule, proteomics and polymer characterization. Protein identification, peptide sequencing, polymer polydispersity and end group determination are covered. Hyphenated techniques such as GC/MS, LC/MS, and LC/QTOF MS are covered. Various MS scan modes (i.e., SIM, SRM, MS/MS) and basic spectrum interpretation are covered. Students are exposed to QET and RRKM theory and select gas phase reactions. The lecture is supplemented with the use of the "Virtual Mass Spectrometry Laboratory" Internet tool, remote control of mass spectrometers and laboratory. 3 hrs. lec., 1.5 hrs. lab.
Prerequisites: 09214 or 09345 or 33341

09-545 Rheology and Structure of Complex Fluids
Intermittent: 9 units

A survey of the mechanical properties of polymeric materials in their many forms: melt, rubber, glass, crystalline, solution, mixtures, and composites with other materials. The dependence on structure of viscosity, viscoelasticity, and plasticity failure. The role of rheological properties in characterization, testing, fabrication, and use of polymeric materials. (Graduate Course: 12 units, 09-745)
Prerequisites: (09344 or 09347) AND (09509 or 06609)

09-560 Molecular Modeling and Computational Chemistry
Fall: 12 units

Computer modeling is playing an increasingly important role in chemical, biological and materials research. This course provides an overview of computational chemistry techniques including molecular mechanics, molecular dynamics, electronic structure theory and continuum medium approaches. Sufficient theoretical background is provided for students to understand the uses and limitations of each technique. An integral part of the course is hands on experience with state-of-the-art computational chemistry tools running on graphics workstations. 3 hrs. lec.
Prerequisites: 15100 and 09344 and 09345

09-604 Introduction to Chemical Kinetics
Spring: Mini Session - 6 units

Empirical description of the time evolution of chemical reactions. Inductive derivation of kinetic rate laws from actual data. Deductive derivation of kinetic rate laws from proposed mechanisms. Gas phase reactions, catalyzed reactions, enzyme kinetics. Theories of kinetic rate constants for gas phase reactions: unimolecular and bimolecular. Theories of solution phase reactions. Absolute reactions rate theory. Diffusion controlled reactions. Kinetics in highly viscous media. Activation energy and entropy. Volume of activation.

09-611 Chemical Thermodynamics

Fall: Mini Session - 6 units
A focused course on chemical thermodynamics. The basic thermodynamic functions will be introduced and discussed. The formal basis for thermochemistry will be presented. Single component phase equilibrium will be considered. The thermodynamic basis of solutions will be developed and applied to

separation methods. The fundamental basis of chemical equilibrium will be developed and applied to a wide variety of reactions. Finally, a few special topics such as self-assembled systems will be presented.

09-612 Introduction to Quantum Chemistry

Spring: Mini Session - 6 units

Introduction to quantum principles. The main topics to be covered include Schrodinger equation, particle in a box, the harmonic oscillator, and rigid rotor. Applications to vibrational, electronic, and NMR spectroscopy. Topics in perturbation theory and time-dependent quantum theory are introduced as well.

09-614 Spectroscopy

Spring: Mini Session - 6 units

This is a course exclusively in optical methods, both time resolved and steady state. In addition to methodology, spectral interpretation in terms of group theory will be discussed. The time-dependent formalism of quantum mechanics will also be introduced. Molecules in gas phase and condensed phase will be discussed. Frequent use will be made of the current literature. Background consisting of undergraduate physical chemistry is assumed. This course has a prerequisite 09-344, Quantum Chemistry or permission of the instructor.

09-701 Quantum Chemistry I

Fall: 12 units

The main topics to be covered will include treatment of the Schrodinger equation, operators, quantum mechanical postulates, particle in the box, harmonic oscillator and hydrogen atom, tunneling, time-independent and time-dependent perturbation theory, matrix diagonalization.

09-702 Statistical Mechanics and Dynamics

Intermittent: 12 units

Application of statistical mechanics to chemical systems. Calculation of thermodynamic functions, phase transitions and chemical equilibrium. Calculation of transport properties of gases and liquids. Elementary theory of chemical kinetics.
Prerequisites: 09611 and 09701

09-705 Chemosensors and Biosensors

Intermittent: 12 units

Chemosensors and biosensors rely on "recognition" and "signaling" elements to transduce a molecular-scale binding event into an observable signal. Students in this course will be introduced to current research and technology for detecting chemical and biological analytes in a variety of contexts, including environmental testing, biological probing and medical diagnostics. Recognition elements ranging from small organic molecules to antibodies will be presented, while various detection modes, including fluorescence, gravimetric and colorimetric, that illustrate different signaling elements will be discussed and compared. Issues to be addressed include sensitivity, selectivity and efficiency. Each sensor will be analyzed in terms of the physical chemistry, organic chemistry and/or biochemistry underlying its function.

09-711 Physical Organic Chemistry

Fall: 12 units

This course introduces students to the study of structure and reactivity of organic compounds from a physical and theoretical standpoint. Students will learn the fundamentals of molecular orbital theory along with some practical applications to aromaticity and anti-aromaticity. Methods are described for the study of reaction mechanisms by means of physical methods such as kinetics, isotope effects, substituent effects, and solvent effects. Important reactive intermediates are described, along with detection methods.

09-712 Ethics and Communication Issues in Scientific Research

Intermittent: Mini Session - 3 units

General synthetic strategies are discussed with a focus on C-C bond formation, functional group transformations, unnatural products and mechanisms.

09-714 Advanced Organic Chemistry

Spring: 12 units

This course will expose the students to modern methods of organic chemistry including insights into the basis and mechanisms of chemical reactions. Topics include but are not limited to: spectroscopic analysis and structure determination, synthetic methods, organic reaction mechanisms, physical organic chemistry, Frontier molecular orbital (FMO) theory. Other topics and the extent of coverage will be determined based on the interests of the class. Upon completion of the course students should be able to design

reaction schemes and evaluate the suitability of modern reagents towards synthesis of complex organic molecules and determine their structures from spectral data. 3 hrs. lec.

09-720 Physical Inorganic Chemistry

Intermittent: 12 units

This course develops principles of magnetochemistry and inorganic spectroscopy. Electronic absorption, magnetic circular dichroism, resonance raman, NMR, EPR, Mossbauer, magnetization and x-ray methods will be introduced with application toward the determination of electronic structures of transition metal complexes.

09-723 Proximal Probe Techniques: New Tools for Nanoscience & Nanotechnology

Intermittent: 12 units

Proximal probe techniques are revolutionizing physical and biological sciences, owing to their ability to explore and manipulate matter at the nanoscale, and to operate in various environments (including liquids). Proximal probe techniques rely on the use of nanoscale probes, positioned and scanned in the immediate vicinity of the material surface. Their development is often viewed as a first step towards nanotechnology, since they demonstrate the feasibility of building purposeful structures one atom or one (macro)molecule at a time. This course is designed for the students of chemistry, biology physics and engineering, who are interested in the fundamentals of proximal probe techniques and in their applications in various areas, converging into a rapidly developing, interdisciplinary field of nanoscience. It will provide physical background of such basic techniques as Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM), and Near-Field Scanning Optical Microscopy (NSOM) and of their variants. Throughout the course, the working "virtual AFM" computer model will be assembled in classroom by each student and then used extensively to gain thorough understanding of AFM operation principles. Particular emphasis will be placed on modes of operation facilitating chemical contrast and contrast based on other material properties. (No prior experience with computer programming required).

09-841 Spectroscopy

Intermittent: 12 units

This course emphasizes the use of modern optical methods in the study of molecular properties and reactivity. Basic topics such as the use of group theory in the analysis of vibrational and electronic spectra are covered in detail. In addition, recently developed techniques such as time-resolved and nonlinear spectroscopies are discussed as are applications of optical methods to problems in chemistry, biology and materials science.
Prerequisites: 09344 and 09345

Language Technologies Institute

11-617 Language Technologies for Computer Assisted Language Learning

Spring: 12 units

This course studies the design and implementation of CALL systems that use Language Technologies such as Speech Synthesis and Recognition, Machine Translation, and Information Retrieval. After a short history of CALL/LT, students will learn where language technologies (LT) can be used to aid in language learning. From there, the course will explore the specifics of designing software that must interface with a language technology, For each LT, we will explore: • what information does the LT require, • what type of output does the LT send to the CALL interface, • what are the limits of the LT that the CALL designer must deal with, • what are the real time constraints, • what type of training does the LT require The goal of the course is to familiarize the student with : • existing systems that use LT • assessment of CALL/LT software • the limitations imposed by the LT • designing CALL/LT software Grading criteria: • several short quizzes • term project: production of a small CALL/LT system, verbal presentation and written documentation of design of the software

11-792 Software Engineering for Information Technology

Spring: 12 units

The Software Engineering for IT sequence combines classroom material and assignments in the fundamentals of software engineering (11-791) with a self-paced, faculty-supervised directed project (11-792). The two courses cover all elements of project design, implementation, evaluation, and documentation. For students intending to complete both courses, it is recommended that the project design and proof-of-concept prototype be completed and approved by the faculty advisor before the start of 11-792, if possible. Students may elect to take only 11-791; however, if both parts are taken, they should be taken in proper sequence.
Prerequisites: 11791 or 15393

Civil & Environmental Engineering

12-090 Technology and the Environment

Spring: 9 units

Overview of major environmental issues and concerns associated with modern technology. Topics in the course include automobiles and associated air emissions and fuel consumption, information technology and electricity usage, electricity generation and alternative sources to reduce air emissions and wastes, CFCs and their influence on the ozone layer, and various issues related to land use patterns such as agriculture and infrastructure. Methods for using technology to improve environmental conditions also discussed. Within this framework the course aims to build fundamental problem solving skills, basic familiarity with engineering calculations, and understanding of everyday environmental issues. The overall purpose is to instill an appreciation of the complexity of issues and viewpoints surrounding technology development and associated environmental impacts.

12-100 Introduction to Civil and Environmental Engineering

Fall and Spring: 12 units

Introduction to selected subfields in the discipline, such as structural engineering, construction project management, and environmental engineering. Problem-solving exercises apply fundamental concepts from these subfields to integrate the steps of analysis, synthesis, and evaluation through individual homework assignments and group projects that require attention to a broad range of issues. The course also exposes the students to issues related to engineering practice such as working in teams, scheduling, evaluating risk and making ethical decisions. In addition to regular lectures and project exercises, the course includes guest speakers and class demonstrations. 3 hrs., rec., 1 hr. lab.

Prerequisites: Corequisites: 21-120, 33-106

12-212 Statics

Fall: 9 units

Introduction to vector mechanics; equivalent systems of forces; equilibrium of rigid bodies; free body diagram; distributed forces, hydrostatic forces, effective forces, centroids; applications to simple statically determinate trusses, beams, frames, cables and other physical systems; friction. 3 hrs. rec.

Prerequisites: Corequisites: 33-103, 21-122, 12-100

12-231 Solid Mechanics

Spring: 9 units

Analysis of deformable bodies incorporating concepts of stress, strain, mechanical properties of materials, and geometric compatibility. Response under axial loads, torsion, bending, transverse shear, and combined loadings. Stress and strain transformations and Mohr's circles, deflections of beams and shafts, buckling of columns.

Prerequisites: 12212 and 21259 Corequisites: 21-260

12-232 Solid Mechanics Lab

Spring: 3 units

Analysis of stress-strain relationships, torsion of solid shafts, deformation due to bending, deformations in three dimensions, Mohr's circle representation of stress and strain, buckling of slender columns. Laboratory experiments and reports associated with theoretical concepts. 1 hr. lab

Prerequisites: 12212 Corequisites: 12-231

12-235 Statics

Spring: 9 units

Prerequisites: Corequisites: 21-122, 12-100, 33-106

12-251 Introduction to Environmental Engineering

Fall: 9 units

Prerequisites: 06101 or 12100

12-252 Introduction Environment Engineering Lab

Fall: 3 units

Corequisites: 12-251

12-271 Introduction to Computer Application in Civil & Environmental Engineering

Spring: 9 units

Introduction to the use of computer-based applications in civil engineering, using generic tools such as spread-sheets, equation solvers and computer graphics. Discussion of the role of computer-based methods in civil engineering practice.

Prerequisites: 21120 and 33106

12-301 Civil Environmental Engineering Projects

Fall: 12 units

Basic elements of civil and environmental engineering projects, from project conception through design, to implementation and operation. Project components are explored through formal instruction combined with analysis of actual engineering projects and student team activities. The course is intended to develop skills and understanding related to the application of engineering and science principles, approximations, empiricism, and experience to engineering projects; basic theory and practice of design; the importance and challenge of team efforts and effective communication; and the utility of measurements, modeling, visualization, quality control, and engineering graphics. 4 hrs. rec.

Prerequisites: 12212 and 12271

12-331 Solid Mechanics

Fall: 9 units

Prerequisites: 12235 Corequisites: 21-259

12-332 Solid Mechanics Lab

Fall: 3 units

Analysis of stress-strain relationships, torsion of solid shafts, deformation due to bending, deformations in three dimensions, Mohr's circle representation of stress and strain, buckling of slender columns. Laboratory experiments and reports associated with theoretical concepts. 1 hr. lab.

Prerequisites: 12235 Corequisites: 12-331

12-335 Soil Mechanics

Fall: 9 units

Sampling, testing and identification of soils. Physical, chemical and hydraulic characteristics. Stress-strain-strength relationships for soils. Permeability, seepage, consolidation, and shear strength, with applications to deformation and stability problems, including earth dams, foundations, retaining walls, slopes and landfills. 3 hrs. rec.

Prerequisites: 12231 Corequisites: 12-355

12-336 Soil Mechanics Laboratory

Fall: 3 units

Examination of material properties and behavior of soils. Experiments include soil classification, permeability, compaction, consolidation and strength tests. 1 hr. lab.

Prerequisites: 12231 Corequisites: 12-335

12-355 Fluid Mechanics

Fall: 9 units

Fluid characteristics; continuity, momentum and energy equations; dynamic similitude; laminar and turbulent boundary layers; flow in pipes; lift and drag on immersed bodies; open channel flow.

Corequisites: 21-260, 21-259

12-356 Fluid Mechanics Lab

Fall: 3 units

Fluid properties: density, specific gravity, viscosity; fluid characteristics; continuity, conservation of energy; fluid behavior: center of pressure, pipe flow, open-channel flow. Laboratory experiments illustrating basic principles. 1 hr. lab.

Corequisites: 12-355

12-358 Materials Lab

Spring: Mini Session - 3 units

Examination of materials properties and behavior of concrete, masonry, and timber. 2 hr. lab

Prerequisites: 27357

12-401 Civil & Environmental Engineering Design

Fall: 15 units

Methodology for formulating and solving design problems, characterized by incomplete specifications, open-ended solution space, and partial evaluations. The methodology is illustrated and applied in the context of realistic design problems drawn from civil and environmental engineering. Design projects performed by teams, emphasizing collaborative problem-solving and preparation of written and oral reports. 2 hrs. rec., 2 hrs. lab. Senior Standing in Civil and Environmental Engineering or instructor approval for Design Minors.

12-411 Project Management Corporation

Fall: Mini Session - 9 units

Basic concepts of economic analysis and evaluation of alternative engineering projects for capital investment. Consideration of time value of money and common merit measures such as net present value and internal rate of return. Selection of independent projects and mutually exclusive proposals, using various methods of analysis. Capital budgeting and project financing. Influence of price

level changes, depreciation and taxation on choice of alternatives. Uncertainty and risk in operation and financing. Important factors affecting investment decisions for private and public projects. 3 hrs. rec. Senior Standing in Civil and Environmental Engineering

12-604 Special Topics: Transportation Engineering
Spring: 9 units

Introduction to traffic engineering and highway design providing practical experience that can be used directly in the workforce. Course material will provide a solid foundation in preparing for the Professional Engineer exam. The course incorporates the "soft" side of transportation engineering with tasks such as traffic analyses and traffic studies and the "hard" side of transportation engineering including traffic signal design, signing design, pavement marking design, maintenance and protection of traffic during construction design, and highway design.

12-605 Design and Construction
Spring: 9 units

Introduction to steel, concrete, wood, and masonry construction methods and material selection; integration of design and constructability criteria; conformance of designs to applicable building and fire codes; preparation of plans and specifications; laboratory demonstration and experiments. 2 hrs. rec., 2 hrs. lab. Instructor approval.
Prerequisites: 12231

12-611 Project Management Construction
Fall: 9 units

12-631 Structural Design
Spring: 12 units

Design of structural members for bending moment, shear force, axial force, and combined axial force and bending. Reinforced concrete, structural steel, and composite beam construction are considered. Buckling effects in columns, beams and local plate segments are treated. Serviceability limits such as deflection and cracking are addressed. Design projects include the determination of loads and the selection of system geometry.
Prerequisites: 12231 and 12358 and 27357

12-635 Structural Analysis
Fall: 9 units

Matrix Algebra. Introduction to the Stiffness Method - spring element, direct stiffness method, stiffness assembly, boundary conditions, potential energy approach; one-dimensional governing equations for heat flow, axial bar, transversely loaded spring, diffusion, electric current, laminar pipe flow; truss analysis; beam analysis; frame and grid analysis, arbitrarily oriented beam in space, substructure analysis; plane stress and plane strain analysis, equations of elasticity, constant strain triangle, body and surface forces, linear strain triangle; axisymmetric elements; isoparametric formulation, bar element, rectangular elements, Gaussian quadrature, high order shape functions.
Prerequisites: 12331

12-636 Geotechnical Engineering
Spring: 9 units

Emphasis is on three major components of geotechnical engineering: (1) planning and design of exploration programs, interpretation of field and laboratory test data for use in geotechnical site characterization; (2) problem definition (e.g., slope stability, settlement analysis, etc.) and development of idealized analytical models; and (3) applications of analytical and numerical methods, particularly computer methods, applied to analysis and design. 3 hrs. rec.
Prerequisites: 12335

12-651 Air Quality Engineering
Fall: 9 units

Problems and methodologies for studies of environmental management, with an emphasis on air pollution. Key topics include sources of pollutants, focusing on combustion chemistry for a hydrocarbon fuel; behavior of gaseous and particulate pollutants in the atmosphere including the role of meteorology and the use of dispersion equations; effects of pollutants on human health and global climate; and procedures by which air pollution standards are developed and enforced by regulatory agencies. Statistical treatment of data is included at several places in the course. 3 hrs. rec.
Prerequisites: 12355 and 36211

12-655 Water Quality Engineering
Fall: 9 units

An introduction to the fundamentals and engineering aspects of water quality. Basic principles of water chemistry; physical,

chemical and biological phenomena affecting water quality; and application of these concepts to a description of water quality changes that may occur in treatment processes and in natural-water environments including water and wastewater treatment systems and groundwater. 3 hrs. rec.

Prerequisites: 09105 and 12251 Corequisites: 12-355

12-656 Water Quality Engineering Lab
Spring: Mini Session - 3 units

Examination of water quality using titrimetric, spectrometric, potentiometric and reductive/oxidative techniques. Illustration of principles of dilute aqueous chemistry and processes for affecting water quality. 2 hrs. lab.
Corequisites: 12-655

12-657 Water Resources Engineering
Spring: 9 units

Principles and applications of open channel flow. Hydrology of surface and ground water sources and the estimation of water requirements. Planning and design of water distribution and wastewater and storm water collection systems. 3 hrs. rec.
Prerequisites: 12251 Corequisites: 12-355

12-658 Hydraulic Structures
Spring: 9 units

Theory and practice of design or riverine and coastal structures, including dams, levees, bridge piers, culverts, jetties and groins, seawalls, bulkheads, breakwaters, marinas, and harbors. Key related concepts from surface and ground water hydrology, and wave mechanics. 3 hrs. rec.
Corequisites: 12-355

12-659 Special Topics: Matlab
Fall: Mini Session - 6 units

This mini course is designed to be a practical introduction to engineering scientific computation. The topics of this class will include basic matrix computation, solving ordinary and partial differential equations, solving systems of linear equations, computing eigenvalues and eigenvectors, and basic signal processing and neural network techniques. Throughout the course, these scientific computation tools will be demonstrated using interactive scientific software called MATLAB.

12-671 Special Topics: Fundamental Concepts of Computing in CEE
Fall: 9 units

The purpose of this course is to introduce students to the important concepts of computing related to civil and environmental engineering. The course will briefly describe the form and operation of modern computational devices, the data structures and algorithms that are used in many of the computations that support CEE software applications, and explore the frontier of applying advanced computing in civil and environmental engineering. Prereq: 15-100, 12-271

12-690 Independent Study
Fall and Spring: 0-48 units

In-depth investigation of a special topic in Civil and Environmental Engineering under the direction of a faculty member. The topic usually involves open-ended problems whose solution requires some elements of syntheses, analysis, construction, testing and evaluation of an engineering device or system. Junior or Senior Standing in Civil and Environmental Engineering. Faculty approval required. 3 to 12 units

Computer Science

15-050 Study Abroad
All Semesters: 0 units

Students who are interested in studying abroad should first contact the Office of International Education. More information on Study Abroad is available on OIE's Study Abroad page and at the CS Undergraduate Office.

15-075 Computer Science Co-Op
All Semesters: 0-3 units

Students who are interested in a Co-Op experience with an external employer typically do so in their Junior year. A Co-Op is distinguished from a summer internship in that it encompasses a summer and a contiguous semester, either Spring-Summer or Summer-Fall. A list of companies who are interested in hiring Co-Op students is available from the SCS Career Consultant at the Career Center. More information on the Computer Science Co-Op program is available at the CS Undergraduate Office.

15-090 Computer Science Practicum

All Semesters: 3 units

This course is for international students who are interested in working for Curricular Practical Training (CPT). Such students interested in CPT must first be authorized by the Office of International Education before being able to enroll in the Practicum course. More information on CPT is available on OIE's Foreign Student Employment page and at the CS Undergraduate Office.

15-100 Introductory/Intermediate Programming

All Semesters: 10 units

An introduction to the process of program design and analysis using the Java programming language for students who have NO prior programming experience. Topics to be covered include basic data types and their operators, I/O, control structures (selection, loops), classes (including methods and fields), arrays, and simple sorting and searching algorithms. Students with prior programming experience are strongly encouraged to take 15-111. If you've taken a programming course in a language other than Java and have used functions, loops, and arrays, you should NOT enroll in 15-100 and instead enroll in 15-111. NOTE: students must achieve a C or better in order to use this course to satisfy the pre-requisite for any subsequent Computer Science course.

15-105 Principles of Computation

Fall and Spring: 9 units

An introduction to principles that form the foundation of computer science for students with no prior background in computing. This course is suitable for students with a non-technical background who wish to study the key principles of computer science rather than just computer programming. Topics include the history of computation, writing algorithms and using programming constructs, data organization, the role of the compiler, programming language paradigm, recursion, algorithm correctness and efficiency, limits of computability and the Turing machine as a universal computer, the role of the operating system, an introduction to artificial intelligence, and alternative models of computation including parallel, quantum and molecular computing. Although programming principles and programming languages will be discussed, there will be no significant programming exercises in this class. Students who are interested in learning how to program in a specific programming language such as Java are encouraged to register for 15-100, 15-111 or 15-200 instead, depending on their prior programming background. Students who have completed 15-211 (or higher) are not permitted to register for this course.

15-111 Intermediate/Advanced Programming

All Semesters: 10 units

A continuation of the process of program design and analysis for students with some prior programming experience (functions, loops, and arrays, not necessarily in Java). The course reinforces object-oriented programming techniques in Java and covers data aggregates, data structures (e.g., linked lists, stacks, queues, trees, and graphs), and an introduction to the analysis of algorithms that operate on those data structures. NOTE: students must achieve a C or better in order to use this course to satisfy the pre-requisite for any subsequent Computer Science course.
Prerequisites: 15100

15-123 Effective Programming in C and UNIX

All Semesters: 9 units

This course is designed to provide a substantial exposure to the C programming language and the Unix programming environment for students with prior programming experience but minimal exposure to C. Features of the C language that are emphasized include arrays, structs and unions, dynamic memory allocation (malloc and free), pointers, pointer arithmetic, and casting. Data structures that are emphasized include lists and hash tables. Students will develop a sense of proper programming style in the C idiom, and will be exposed to cross-platform portability issues. Students will learn to use tools such as emacs/vi, make, and gdb to assist them in the design, testing and debugging of their programs. Students will learn about regular expressions and grep and will be able to use a scripting language such as Perl to solve simple problems. NOTE: students must achieve a C or better in order to use this course to satisfy the pre-requisite for 15-213.
Prerequisites: 15100

15-211 Fundamental Data Structures and Algorithms

All Semesters: 12 units

Fundamental programming concepts are presented together with supporting theoretical foundations and practical applications. This course emphasizes the practical application of techniques for writing and analyzing programs: data abstraction, program verification, and performance analysis. These techniques are applied in the design

and analysis of fundamental algorithms and data structures. The course is currently taught in Java. NOTE: students must achieve a C or better in order to use this course to satisfy the pre-requisite for any subsequent Computer Science course.

Prerequisites: 15111 and 21127

15-212 Principles of Programming

Fall and Spring: 12 units

This course presents principles and techniques of programming, focusing on sophisticated methods for specifying, constructing, and reasoning about computer programs. Via features of a high-level functional programming language (currently ML), this course concretely illustrates mechanisms for building user-defined data types, including recursive and polymorphic types, and infinite data structures such as streams; for building higher-order control constructs such as first-class functions and continuations; and for building large programs using advanced module composition. It also introduces the use of formal methods for specifying and verifying programs.

Prerequisites: 15251

15-213 Introduction to Computer Systems

Fall and Spring: 12 units

This course provides a programmer's view of how computer systems execute programs, store information, and communicate. It enables students to become more effective programmers, especially in dealing with issues of performance, portability and robustness. It also serves as a foundation for courses on compilers, networks, operating systems, and computer architecture, where a deeper understanding of systems-level issues is required. Topics covered include: machine-level code and its generation by optimizing compilers, performance evaluation and optimization, computer arithmetic, memory organization and management, networking technology and protocols, and supporting concurrent computation. NOTE: students must achieve a C or better in order to use this course to satisfy the pre-requisite for any subsequent Computer Science course.

Prerequisites: 15123

15-221 Technical Communication for Computer Scientists

Fall and Spring: 9 units

The course is designed for sophomore computer science majors to improve their abilities in practical, professional communications (both written and oral). It aims to help students compose clear, concise technical writings and oral presentations for multi-level audiences. Assignments include technical definitions, descriptions, instructions, process explanations, abstracts, memos, and research reports. Assignments may incorporate recent computer science research at Carnegie Mellon, projects in related technical courses, and professional case studies.

Prerequisites: 76101

15-251 Great Theoretical Ideas in Computer Science

Fall and Spring: 12 units

This course is about how to use theoretical ideas to formulate and solve problems in computer science. It integrates mathematical material with general problem solving techniques and computer science applications. Examples are drawn from Algorithms, Complexity Theory, Game Theory, Probability Theory, Graph Theory, Automata Theory, Algebra, Cryptography, and Combinatorics. Assignments involve both mathematical proofs and programming. NOTE: students must achieve a C or better in order to use this course to satisfy the pre-requisite for any subsequent Computer Science course.

Prerequisites: (15100 or 15111) and 21127

15-295 Special Topic: Competition Programming and Problem Solving

Fall and Spring: 3-6 units

Each year, Carnegie Mellon fields two teams for participation in the ACM-ICPC Regional Programming Contest. During many recent years, one of those teams has earned the right to represent Carnegie Mellon at the ACM-ICPC World Finals. This course is a vehicle for those who consistently and rigorously train in preparation for the contests to earn course credit for their effort and achievement. Preparation involves the study of algorithms, the practice of programming and debugging, the development of test sets, and the growth of team, communication, and problem solving skills. Neither the course grade nor the number of units earned are dependent on ranking in any contest. Students are not required to earn course credit to participate in practices or to compete in ACM-ICPC events. Consistent, disciplined participation in team practices and associated individual preparation earns three (3) units of credit. Six (6) units of credit are possible for those who routinely complete significant homework and/or teamwork assignments outside of

normal group meetings. Students interested in the course should attend during the first week of classes to discuss enrollment details.
Prerequisites: 15211

15-312 Foundations of Programming Languages
Spring: 12 units

This course discusses in depth many of the concepts underlying the design, definition, implementation, and use of modern programming languages. Formal approaches to defining the syntax and semantics are used to describe the fundamental concepts underlying programming languages. A variety of programming paradigms are covered such as imperative, functional, logic, and concurrent programming. In addition to the formal studies, experience with programming in the languages is used to illustrate how different design goals can lead to radically different languages and models of computation.

Prerequisites: 15212

15-313 Foundations of Software Engineering
Spring: 12 units

Students gain exposure to the fundamentals of modern software engineering. This includes both core CS technical knowledge and the means by which this knowledge can be applied in the practical engineering of complex software. Topics related to software artifacts include design models, patterns, coding, static and dynamic analysis, testing and inspection, measurement, and software architecture and frameworks. Topics related to software process include modeling, requirements engineering, process models and evaluation, team development, and supply chain issues including outsourcing and open source. This course has a strong technical focus, and will include both written and programming assignments. Students will get experience with modern software engineering tools and, later in the semester, create one of their own.

Prerequisites: 15211 and (15212 or 15213)

15-317 Constructive Logic
Fall: 9 units

This multidisciplinary junior-level course is designed to provide a thorough introduction to modern constructive logic, its roots in philosophy, its numerous applications in computer science, and its mathematical properties. Some of the topics to be covered are intuitionistic logic, inductive definitions, functional programming, type theory, realizability, connections between classical and constructive logic, decidable classes. This course counts as a Fundamentals course in the Computer Science major.

Prerequisites: 15212

15-321 Research Methods for Experimental Computer Science
Fall: 12 units

The success or failure of an experiment can turn on the details of how the experiment was performed -- the experimental method. It is critical that the methodology be consistent with whatever research hypothesis is being pursued. The goal of this project-based course is to give students familiarity with and appreciation for the subtleties of a range of experimental techniques essential to high-quality empirical research. The course is based on a project that will illustrate important concepts of research methods. Example topics include user-study design and operation, data gathering, data diagnosis, experiment design and execution, signal detection, performance evaluation, error analysis, reporting results, etc. The project will explore the challenging open problem of keystroke dynamics, a biometric regime which seeks to identify/authenticate/discriminate users on the basis of their typing styles. In this context, numerous methodological issues provide the stimulus for learning how to perform empirical research from the beginning to the end of a project. Lectures will present necessary background material about the problem area and experimental methods; homework assignments and a team project will give students guided, hands-on, research and practical experience. At the end of the course, students will be acquainted with the basic issues in experimental methods, and will be able to perform independent work using the lessons learned and resources provided. Enrollment is limited to graduate students, juniors, and seniors. It will be helpful for students to have some experience with scripting languages (e.g., Perl, Python, Tcl, etc), statistically-oriented packages (e.g., R, Matlab, Weka) or other implementations of various machine-learning-type classifiers. This course can be used to satisfy the Lab requirement for the Computer Science major.

Prerequisites: 15213

15-322 Introduction to Computer Music
Spring: 9 units

Computers are used to synthesize sound, process signals, and compose music. Personal computers have replaced studios full of sound recording and processing equipment, completing a revolution

that began with recording and electronics. In this course, students will learn the fundamentals of digital audio, basic sound synthesis algorithms, and techniques for digital audio effects and processing. Students will apply their knowledge in programming assignments using a very high-level programming language for sound synthesis and composition. In a final project, students will demonstrate their mastery of tools and techniques through music composition or by the implementation of a significant sound-processing technique.

Prerequisites: 15100

15-323 Music Systems and Information Processing
Fall: 9 units

This course presents concepts and techniques for representing and manipulating discrete music information, both in real time and off line. Representations of music as explicitly timed event sequences will be introduced, and students will learn how to build efficient run-time systems for event scheduling, tempo control, and interactive processing. The MIDI protocol is used to capture real-time performance information and to generate sound. The course will also cover non-real-time processing of music data, including Markov models, style recognition, computer accompaniment, query-by-humming, and algorithmic composition. This course is independent of, and complementary to 15-322, Introduction to Computer Music, which focuses on sound synthesis and signal processing.

Prerequisites: 15211

15-354 Computational Discrete Mathematics
Fall: 12 units

This course is about the computational aspects of some of the standard concepts of discrete mathematics (relations, functions, logic, graphs, algebra, automata), with emphasis on efficient algorithms. We begin with a brief introduction to computability and computational complexity. Other topics include: iteration, orbits and fixed points, order and equivalence relations, propositional logic and satisfiability testing, finite fields and shift register sequences, finite state machines, and cellular automata. Computational support for some of the material is available in the form of a Mathematica package.

Prerequisites: 15251

15-355 Modern Computer Algebra
Fall: 9 units

The goal of this course is to investigate the relationship between algebra and computation. The course is designed to expose students to algorithms used for symbolic computation, as well as to the concepts from modern algebra which are applied to the development of these algorithms. This course provides a hands-on introduction to many of the most important ideas used in symbolic mathematical computation, which involves solving system of polynomial equations (via Groebner bases), analytic integration, and solving linear difference equations. Throughout the course the computer algebra system Mathematica will be used for computation.

Prerequisites: 15251

15-359 Special Topic: Probability and Computing
Fall: 12 units

Probability theory has become indispensable in computer science. In areas such as artificial intelligence and computer science theory, probabilistic methods and ideas based on randomization are central. In other areas such as networks and systems, probability is becoming an increasingly useful framework for handling uncertainty and modeling the patterns of data that occur in complex systems. This course gives an introduction to probability as it is used in computer science theory and practice, drawing on applications and current research developments as motivation and context. Topics include combinatorial probability and random graphs, heavy tail distributions, concentration inequalities, various randomized algorithms, sampling random variables and computer simulation, and Markov chains and their many applications, from Web search engines to models of network protocols. The course will assume familiarity with basic calculus and linear algebra.

Prerequisites: 15211 and 15251

15-381 Artificial Intelligence: Representation and Problem Solving
Spring: 9 units

This course is about the theory and practice of Artificial Intelligence. We will study modern techniques for computers to represent task-relevant information and make intelligent (i.e. satisficing or optimal) decisions towards the achievement of goals. The search and problem solving methods are applicable throughout a large range of industrial, civil, medical, financial, robotic, and information systems. We will investigate questions about AI systems such as: how to represent knowledge, how to effectively generate appropriate sequences of actions and how to search among alternatives to find optimal or near-optimal solutions. We will also explore how to deal with uncertainty in the world, how to learn from experience, and

how to learn decision rules from data. We expect that by the end of the course students will have a thorough understanding of the algorithmic foundations of AI, how probability and AI are closely interrelated, and how automated agents learn. We also expect students to acquire a strong appreciation of the big-picture aspects of developing fully autonomous intelligent agents. Other lectures will introduce additional aspects of AI, including natural language processing, web-based search engines, industrial applications, autonomous robotics, and economic/game-theoretic decision making.
Prerequisites: 15211

15-384 Robotic Manipulation

Fall: 12 units

Foundations and principles of robotic manipulation. Topics include computational models of objects and motion, the mechanics of robotic manipulators, the structure of manipulator control systems, planning and programming of robot actions.

Prerequisites: 15111 and (18202 or 21241 or 24311)

15-385 Computer Vision

Spring: 9 units

An introduction to the science and engineering of computer vision, i.e. the analysis of the patterns in visual images with the view to understanding the objects and processes in the world that generate them. Major topics include image formation and sensing, Fourier analysis, edge and contour detection, inference of depth, shape and motion, classification, recognition, tracking, and active vision. The emphasis is on the learning of fundamental mathematical concepts and techniques and applying them to solve real vision problems. The discussion will also include comparison with human and animal vision from psychological and biological perspectives. Students will learn to think mathematically and develop skills in translating ideas and mathematical thoughts into programs to solve real vision problems.
Prerequisites: 15123 and (18202 or 21241)

15-386 Computational Neuroscience: Visual Computation in Biological Systems

Spring: 9 units

An introduction to the computational and system neuroscience of visual perception and object recognition. We will study how the brain processes visual information that enables us to see, from computational, psychological and neurobiological perspectives. Students will gain an in-depth understanding of the working of visual systems down to the neuronal level, and learn to apply computational thinking and tools to solve engineering puzzles underlying vision. The course is appropriate for computer science, engineering, physics, psychology and neuroscience students who have at least a course in computer programming, a course in linear algebra and differential equations or a course in probability and statistics. Counted as a core application elective for CS majors. 15-686 option requires additional weekly meeting to discuss current papers on visual computation.

Prerequisites: 15123 and (18202 or 21241)

15-390 Entrepreneurship for Computer Science

Fall: 9 units

This course is an introduction to Entrepreneurship designed to develop skills related to entrepreneurship and innovation for non-business undergraduate and graduate students in the School of Computer Science. The course assumes no background courses in business and is appropriate for those who are interested in bringing innovations to market either through new companies or existing companies. The course provides an overview of entrepreneurship and innovation, develops an entrepreneurial frame of mind, and provides a framework for learning the rudiments of how to generate ideas. Students come up with or are presented with potential ideas and learn how to develop these ideas into opportunities, and to explore their potential for becoming viable businesses. They learn how to do market research, to develop go-to-market strategies, value propositions and to differentiate their products or services from potential competitors. The focus is on understanding and developing strategies for approaching the key elements of the entrepreneurial process – opportunity, resources and team. The course consists of a balance of lectures, case studies and encounters with entrepreneurs, investors and business professionals. The students are exposed to financial and intellectual property issues, and encounter a real world perspective on entrepreneurship, innovation and leadership. The output of the course is a “mini-business plan” or venture opportunity screening document that can be developed into a business plan in a subsequent course entitled New Venture Creation or through independent study.

15-391 Technology Consulting in the Community

Fall and Spring: 9 units

In this course, the student develops technical consulting and management skills while collaborating on site with a community leader of a non-profit community organization. This service-learning course de-emphasizes coding, asking the student instead to analyze a complex organization, then design and implement a work plan that will expand the organization's capacity to use information technology. Throughout the semester, students develop a consulting report. They learn how to use this working document to collaborate with others and to think through and communicate a strategic technology plan. Students also experience how urban community organizations function, seeing the valuable benefits these organizations provide to society.

Prerequisites: 76101 and (15111 or 70451)

15-392 Special Topic: Secure Programming

Spring: 9 units

This course provides a detailed explanation of common programming errors in C and C++ and describes how these errors can lead to software systems that are vulnerable to exploitation. The course concentrates on security issues intrinsic to the C and C++ programming languages and associated libraries. It does not emphasize security issues involving interactions with external systems such as databases and web servers, as these are rich topics on their own. Topics to be covered include the secure and insecure use of integers, arrays, strings, dynamic memory, formatted input/output functions, and file I/O.

Prerequisites: 15213

15-410 Operating System Design and Implementation

Fall and Spring: 12 units

Operating System Design and Implementation is a rigorous hands-on introduction to the principles and practice of operating systems. The core experience is writing a small Unix-inspired OS kernel, in C with some x86 assembly language, which runs on a PC hardware simulator (and on actual PC hardware if you wish). Work is done in two-person teams, and team programming skills (source control, modularity, documentation) are emphasized. The size and scope of the programming assignments typically result in students significantly developing their design, implementation, and debugging abilities. Core concepts include the process model, virtual memory, threads, synchronization, and deadlock; the course also surveys higher-level OS topics including file systems, interprocess communication, networking, and security. (Graduate) students who have not satisfied the prerequisite at Carnegie Mellon are strongly cautioned - to enter the class you must be able to write a storage allocator in C, use a debugger, understand 2's-complement arithmetic, and translate between C and x86 assembly language. The instructor may require you to complete a skills assessment exercise before the first week of the semester in order to remain registered in the class.

Prerequisites: 15213

15-411 Compiler Design

Fall: 12 units

This course covers the design and implementation of compiler and run-time systems for high-level languages, and examines the interaction between language design, compiler design, and run-time organization. Topics covered include syntactic and lexical analysis, handling of user-defined types and type-checking, context analysis, code generation and optimization, and memory management and run-time organization.

Prerequisites: 15213 or 15312

15-412 Operating System Practicum

Fall: 9,12 units

The goal of this class is for students to acquire hands-on experience with operating-system code as it is developed and deployed in the real world. Groups of two to four students will select, build, install, and become familiar with an open-source operating system project; propose a significant extension or upgrade to that project; and develop a production-quality implementation meeting the coding standards of that project. Unless infeasible, the results will be submitted to the project for inclusion in the code base. Variations on this theme are possible at the discretion of the instructor. For example, it may be possible to work within the context of a non-operating-system software infrastructure project (window system, web server, or embedded network device kernel) or to extend a 15-410 student kernel. In some situations students may work alone. Group membership and unit count (9 units versus 12) will be decided by the third week of the semester. Contributing to a real-world project will involve engaging in some mixture of messy, potentially open-ended activities such as: learning a revision control system, writing a short design document, creating and updating a simple project plan, participating in an informal code review,

synthesizing scattered information about hardware and software, classifying and/or reading large amounts of code written by various people over a long period of time, etc.

Prerequisites: 15410

15-413 Software Engineering Practicum

Fall: 12 units

This course is modeled after the successful MSE studio and MSIT practicum experiences used in the ISR software engineering masters programs. Students will carry out a semester-long project for a real client in small teams. A few lectures at the beginning of the course will introduce the process, tools, and documents to be used in the course, all of which will be specified by the instructors. Throughout the project, groups will be mentored through weekly team meetings with faculty. Teams will make regular presentations on the following topics: risk management, project planning, requirements, architecture, detailed design, quality assurance, final product presentations, and reflections on the experience. Teams will also deliver documents on each of the above topics. Evaluation will be based on the in-class presentations, process and product documentation deliverables, how well the teams follow SE practices as judged by their mentor, and finally the client's satisfaction with the product. Individual grades within a team will be influenced by peer reviews, individual reflection documents, mentor impressions, and presentation performance. Students will leave the course with a firsthand understanding of the software engineering realities that drive SE practices. They will have concrete experience with these practices, and will have engaged in active reflection on this experience. They will have teamwork, process, and product skills to support immediate competency in a software engineering organization, along with a deeper understanding that prepares them to evaluate the new processes and techniques they will encounter in the workplace.

Prerequisites: 15313

15-414 Bug Catching: Automated Program Verification and Testing

Fall: 9 units

Many CS and ECE students will be developing software and hardware that must be ultra reliable at some point in their careers. Logical errors in such designs can be costly, even life threatening. There have already been a number of well publicized errors like the Intel Pentium floating point error and the Ariane 5 crash. In this course we will study tools for finding and preventing logical errors. Three types of tools will be studied: automated theorem proving, state exploration techniques like model checking and tools based on static program analysis. Although students will learn the theoretical basis for such tools, the emphasis will be on actually using them on real examples. This course can be used to satisfy the Fundamentals of Algorithms requirement for the Computer Science major.

Prerequisites: 15211 and 15251

15-415 Database Applications

Fall: 12 units

This course covers the fundamental topics for Database Management Systems: Database System Architectural Principles (ACID properties; data abstraction; external, conceptual, and internal schemata; data independence; data definition and data manipulation languages), Data models (entity-relationship and relational data models; data structures, integrity constraints, and operations for each data model; relational query languages: SQL, algebra, calculus), Theory of database design (functional dependencies; normal forms; dependency preservation; information loss), Query Optimization (equivalence of expressions, algebraic manipulation; optimization of selections and joins), Storage Strategies (indices, B-trees, hashing), Query Processing (execution of sort, join, and aggregation operators), and Transaction Processing (recovery and concurrency control).

Prerequisites: 15211 and 15213

15-418 Parallel Computer Architecture and Programming

Spring: 12 units

The fundamental principles and engineering tradeoffs involved in designing modern parallel computers, as well as the programming techniques to effectively utilize these machines. Topics include naming shared data, synchronizing threads, and the latency and bandwidth associated with communication. Case studies on shared-memory, message-passing, data-parallel and dataflow machines will be used to illustrate these techniques and tradeoffs. Programming assignments will be performed on one or more commercial multiprocessors, and there will be a significant course project.

Prerequisites: 15213 or 18347

15-421 Web Commerce, Security and Privacy

Fall: 12 units

Course Objective: The objective of this course is to introduce students to the technologies of Web Commerce, Security and Privacy as well as to related business, policy and usability issues. Content: Over the past ten years, the Web has become an integral part of our daily life, whether at home or at work. This course provides students with an overview of the technologies and practices associated with Web Security, Privacy and Commerce. The course is organized around three parts: Part I - Web Security & Privacy Technologies The big picture, gentle introduction to cryptography, digital signatures, key management, authentication, Internet security protocols, certificates & PKI, decentralized trust management, privacy enhancing technologies, electronic payments Part II - Ethical, Social and Political Issues Sample Topics: Privacy (e.g. FTC FIP, EU Data Protection Directive), Digital Millennium Copyright Act, Internet Governance and Domain Names (ICANN), legal framework for web commerce, etc. (Note : a number of related issues are also addressed in Part I and III). Part III - Web Commerce The big picture, Internet marketing & personalization, search engines, B2B and electronic markets, P2P, Web 2.0, Mobile Commerce. Format: Lectures (including guest lectures), discussions, student presentations, and class projects.

Prerequisites: 15211

15-437 Web Application Development

Fall and Spring: 12 units

This course will introduce concepts in programming web application servers. We will study the fundamental architectural elements of programming web sites that produce content dynamically. The primary technology introduced will be Java Servlets and Java Server Pages (JSPs), but we will cover related topics as necessary so that students can build significant applications. Such topics include: HTTP, HTML and XML, JavaBeans, Design Patterns (e.g., Abstract Factories and Model-View-Controller), Tag Libraries (JSTL), Relational Databases (MySQL/JDBC), Object-Relation Mapping tools (BeanFactory), Security (including SSL), Web Services (SOAP/WSDL/UDDI), Frameworks (Struts), Internationalization, and Scalability and Performance Issues. Students must provide their own computer hardware for this course. Please see the Related URL above for more information.

Prerequisites: 15211

15-440 Computer Systems Fundamentals

Fall: 12 units

The primary objective of this course is for students to gain understanding of the fundamental principles underlying the broad and interesting area of the computer sciences that we often call "systems". Unlike other systems courses that achieve depth within a specific domain, such as operating systems, distributed systems, databases, networks, massively parallel systems, or security, this course takes a broader view. Interesting challenges across these domains are used to highlight the common themes and techniques including scarcity, scheduling, concurrency and concurrent programming, abstraction and modularity, imperfect communication and other types of failure, protection from accidental and malicious harm, optimism, and the use of tools in problem solving. As the creation and management of software systems is a fundamental goal of any undergraduate systems course, students will design, implement, and debug large programming projects. As a consequence competency in both The C Programming Language and Java is required.

Prerequisites: 15111 and 15213

15-441 Computer Networks

Fall and Spring: 12 units

15-441 is an introductory course in computer networks. The emphasis will be on the basic performance and engineering tradeoffs in the design and implementation of computer networks. To make the issues more concrete, the class includes several multi-week projects requiring significant design and implementation. The goal is for students to learn not only what computer networks are and how they work today, but also why they are designed the way they are and how they are likely to evolve in the future. We will draw examples primarily from the Internet. Topics to be covered include: congestion/flow/error control, routing, addressing, naming, multi-casting, switching, internetworking, and network security. Evaluation is based on homework assignments, the projects, and two mid-term exams.

Prerequisites: 15213

15-451 Algorithm Design and Analysis

Fall and Spring: 12 units

This course is about the design and analysis of algorithms. We study specific algorithms for a variety of problems, as well as general design and analysis techniques. Specific topics include searching,

sorting, algorithms for graph problems, efficient data structures, lower bounds and NP-completeness. A variety of other topics may be covered at the discretion of the instructor. These include parallel algorithms, randomized algorithms, geometric algorithms, low level techniques for efficient programming, cryptography, and cryptographic protocols.

Prerequisites: 15211 and 15251

15-453 Formal Languages and Automata

Spring: 9 units

An introduction to the fundamental ideas and models underlying computing: finite automata, regular sets, pushdown automata, context-free grammars, Turing machines, undecidability, and complexity theory.

Prerequisites: 15211 and 15251

15-462 Computer Graphics

Fall and Spring: 12 units

This course provides a comprehensive introduction to computer graphics modeling, animation, and rendering. Topics covered include basic image processing, geometric transformations, geometric modeling of curves and surfaces, animation, 3-D viewing, visibility algorithms, shading, and ray tracing.

Prerequisites: (15213 and 21241 and 21259) or (15213 and 18202)

15-463 Computational Photography

Fall: 12 units

Computational Photography is an emerging new field created by the convergence of computer graphics, computer vision and photography. Its role is to overcome the limitations of the traditional camera by using computational techniques to produce a richer, more vivid, perhaps more perceptually meaningful representation of our visual world. The aim of this advanced undergraduate course is to study ways in which samples from the real world (images and video) can be used to generate compelling computer graphics imagery. We will learn how to acquire, represent, and render scenes from digitized photographs. Several popular image-based algorithms will be presented, with an emphasis on using these techniques to build practical systems. This hands-on emphasis will be reflected in the programming assignments, in which students will have the opportunity to acquire their own images of indoor and outdoor scenes and develop the image analysis and synthesis tools needed to render and view the scenes on the computer.

Prerequisites: (15213 and 21241 and 21259) or (15213 and 18202)

15-464 Technical Animation

Fall: 12 units

This course introduces techniques for computer animation such as keyframing, procedural methods, motion capture, and simulation. The course also includes a brief overview of story-boarding, scene composition, lighting and sound track generation. The second half of the course will explore current research topics in computer animation such as dynamic simulation of flexible and rigid objects, automatically generated control systems, and evolution of behaviors. The course should be appropriate for graduate students in all areas and for advanced undergraduates.

Prerequisites: 15462

15-465 Animation Art and Technology

Spring: 12 units

Animation Art and Technology is an interdisciplinary course cross-listed between Art and Computer Science. Faculty and teaching assistants from computer science and art teach the class as a team. It is a project-based course in which four to five interdisciplinary teams of students produce animations. Most of the animations have a substantive technical component and the students are challenged to consider innovation with content to be equal with the technical. The class includes basic tutorials for work in Maya leading toward more advanced applications and extensions of the software such as motion capture and algorithms for animating cloth, hair, particles, and grouping behaviors. The first class will meet in CFA room 303.

Prerequisites: 15462

15-466 Computer Game Programming

Spring: 12 units

This course will cover tools and techniques for programming interactive games and virtual reality simulations. The course will focus primarily on programming aspects, including event loops and execution threads, graphics and animation in 2D and 3D, terrain/background representation, collision detection and physically-based modeling, game AI, and multi-user games and networking. Although this course has a heavy programming focus, other topics briefly covered will include the history of computer/video game technology, game genres and design principles, and the social impact of games. Students will design and program their own games or virtual reality

simulations as individual class projects using OpenGL and other standard APIs commonly used in game programming.

Prerequisites: 15462

15-482 Human Language Technologies

Fall: 12 units

During the last decade computers have begun to understand human languages. Web search engines, language analysis programs, machine translation systems, speech recognition, and speech synthesis are used every day by tens of millions of people in a wide range of situations and applications. This course covers the fundamental statistical and symbolic algorithms that enable computers to work with human language, from text processing to understanding speech and language. It provides detailed coverage of current techniques, their successes, their limitations, and current research directions. Homework assignments give hands-on experience with four different language technologies, using Internet Movie Database (IMDB) data. Students write programs that answer questions about movies using information obtained from a search engine or a structured database, automatically select good translations of French movie titles, and read movie information in computer-generated voices that sound as natural as possible.

Prerequisites: 15211

15-485 Computational Perception

Intermittent: 9 units

The goal of this course is to teach how to reason scientifically about problems and issues in perceptual cognition, how to extract the essential computational properties of those abstract ideas, and finally how to convert these into explicit mathematical models and computational algorithms. The course teaches advanced aspects of perception, scene analysis, and recognition in both the visual and auditory modalities, concentrating on those aspects that allow us and animals to behave in natural, complex environments. Both the experimental approaches of scientific disciplines and the computational approaches of engineering disciplines are emphasized. Each topic in the course begins by studying the etiology of natural behaviors, analyzing and decomposing these to identify the essential components that are required for the total behavior in a natural environment. This aspect of the course follows the lines of scientific reasoning and key experimental results that lead to our current understanding of the important computational problems in perception and scene analysis. The course then surveys the most important solutions to these problems, focusing on the idealizations and simplifications that are sensory coding, perceptual invariance, spatial vision and sound localization, visual and auditory scene segmentation, many aspects of attention, and the basics of objects and speech recognition.

Prerequisites: 15385 or 85370

15-490 Special Topic: Computational Neuroscience

Intermittent: 9 units

An introduction to computational neuroscience, i.e. the application of computational and mathematical concepts and techniques to the study of the brain. Students will learn the fundamentals of signals and systems, pattern analysis, probability theory and information theories and apply these techniques to study how the real nervous systems compute, communicate and learn at many levels, from synapses to neurons, from neuronal populations to systems. Topics include basic anatomy and physiology of neurons and the mammalian nervous systems, biophysics of single neurons, excitable membranes and cable equation, encoding and decoding of information in single neurons and neuronal ensembles, neural adaptation and learning, signal detection and reconstruction, distributed and hierarchical computations. Concrete examples will be drawn from visual and motor systems and studied from both biological and computational perspectives. Students will do a number of Matlab programming and mathematical exercises to consolidate their learning, participate in the analysis of real neuronal data. No prior background in biology is assumed. A graduate option of the course is offered concurrently to graduate students from all disciplines in science and engineering, including psychology and computational biology.

Prerequisites: 15113 and (18202 or 21241)

15-519 Independent Study in Programming Systems

Fall and Spring: 3-18 units

15-529 Independent Study in Human-Computer Interaction

Fall and Spring: 3-18 units

15-539 Independent Study in Computer Science Pedagogy

Fall and Spring: 3-18 units

15-549 Independent Study in Computer Systems

Fall and Spring: 3-18 units

15-559 Independent Study in Theoretical Computer Science
Fall and Spring: 3-18 units

15-569 Independent Study in Graphics
Fall and Spring: 3-18 units

15-579 Independent Study in Robotics
Fall and Spring: 3-18 units

15-589 Independent Study in Artificial Intelligence
Fall and Spring: 3-18 units

15-599 Undergraduate Thesis Research
Fall and Spring: 3-18 units
Available only to students registered in the CS Senior Research Thesis Program. More information is available at the CS Undergraduate Office.

15-610 Engineering Complex, Large-Scale Computer Systems
Spring: 12 units
This is a master's level course for students with strong design and implementation skills who are likely to pursue careers as software architects and lead engineers. It may be taken by well-prepared undergraduates with excellent design and implementation skills in low-level systems programming. The course assumes a high level of proficiency in all aspects of operating system design and implementation. This course will help students prepare for leadership roles in creating and evolving the complex, large-scale computer systems that society will increasingly depend on in the future. The course will teach the organizing principles of such systems, identifying a core set of versatile techniques that are applicable across many system layers. Students will acquire the knowledge base, intellectual tools, hands-on skills and modes of thought needed to build well-engineered computer systems that withstand the test of time, growth in scale, and stresses of live use. Topics covered include: caching, prefetching, damage containment, scale reduction, hints, replication, hash-based techniques, and fragmentation reduction. A substantial project component is an integral part of the course. A high level of proficiency in systems programming is expected.
Prerequisites: 15410

Robotics

16-221 Robots to the Rescue: A Gentle Introduction to Mobile Robotics
All Semesters: 12 units
This course has been designed to teach the basic tools and techniques of engineering and programming a mobile robot. Student teams will learn to program it to perform increasingly sophisticated behaviors. Besides providing an introduction to autonomous mobile robot technologies, the students also learn key concepts of mechanics, electronics, programming, and systems design and integration. Maybe most important, the students will learn how to use the system for solving interesting and challenging problems in rescue robotics. Programming experience is desirable. If you have any questions regarding this course, please contact Sung Ju Cho at sungjuc@andrew.cmu.edu

16-264 Humanoids
Spring: 12 units
This course will survey work on humanoid robots and simulated humans in movies, games and other applications. Topics will be taken from perception including visual, auditory, and tactile perception, cognition including reacting, planning, and learning, and movement generation including kinematics, dynamics, control, manipulation, and bipedal locomotion.

16-299 Introduction to Feedback Control Systems
Spring: 12 units
This course is designed as a first course in feedback control systems for computer science majors. Course topics include classical linear control theory (differential equations, Laplace transforms, feedback control), linear state-space methods (controllability/observability, pole placement, LQR), nonlinear systems theory, and an introduction to control using computer learning techniques. Laboratory work includes implementation of controllers robotic devices. Priorities will be given to computer science majors with robotics minor.
Prerequisites: 15211 and 21122

16-311 Introduction to Robotics
Fall and Spring: 12 units
This course presents an overview of robotics in practice and research with topics including vision, motion planning, mobile

mechanisms, kinematics, inverse kinematics, and sensors. In course projects, students construct robots which are driven by a microcontroller, with each project reinforcing the basic principles developed in lectures. Students nominally work in teams of three: an electrical engineer, a mechanical engineer, and a computer scientist. This course will also expose students to some of the contemporary happenings in robotics, which includes current robot lab research, applications, robot contests and robots in the news.
Prerequisites: 15111 or 15123

16-362 Mobile Robot Programming Laboratory
Fall: 12 units
This laboratory course is heavy on practical experience and light on lectures. Using Nomad Scouts, and a nice Java programming environment, including a robot simulator, students work in teams of 3 to implement an entire mobile robot software system over the course of the semester. Systems implemented include motion control, odometry (dead reckoning), visual servoing, map-based position estimation, obstacle avoidance, path planning, and multi-robot coordination. The course culminates in a final competition where teams have their robots compete against each other in a day long spectacle.

16-363 Advanced Mobile Robot Programming
Spring: 9,12 units
Advanced Mobile Robot Programming is an advanced research and development course for graduates of 16362 and 16862. In this class, teams of students conduct research and prototype working robot architectures that are research-quality. The best robot systems are generally demonstrated at the National Conference on Artificial Intelligence.
Prerequisites: 16362

16-421 Vision Sensors
Spring: 12 units
This course covers the fundamentals of vision cameras and other sensors - how they function, how they are built, and how to use them effectively. The course presents a journey through the fascinating five hundred year history of "camera-making" from the early 1500's "camera obscura" through the advent of film and lenses, to today's mirror-based and solid state devices (CCD, CMOS). The course includes a significant hands-on component where students learn how to use the sensors and understand, model and deal with the uncertainty (noise) in their measurements. While the first half of the course deals with conventional "single viewpoint" or "perspective" cameras, the second half of the course covers much more recent "multi-viewpoint" or "multi-perspective" cameras that includes a host of lenses and mirrors.
Prerequisites: 21111 and 21341

Software Engineering

17-400 Electronic Voting
Fall: 12 units
After the punched-card disaster in Florida in 2000, the U.S. has been rushing to replace old voting equipment with direct-recording electronic (DRE) machines (sometimes incorrectly lumped together as "touchscreens"). Recent examination of these machines by computer security experts has revealed significant security vulnerabilities, leading to a call by some computer scientists to either discontinue use of such machines or equip them with a printing device that would enable the voter to see a paper record of how she had voted before leaving the voting booth. This "voter-verifiable paper trail" idea has polarized the voting community, leading to bills in Congress and in some states to require it but with vendors, election officials and public advocacy groups strongly in opposition. Each meeting will be devoted to a technical lecture followed by an hour of general discussion. The course is open to juniors, seniors and graduate students. Students from outside SCS are welcome. No advanced technical background is required except for some security and cryptography topics. Each student will participate in a team project, with a presentation to be made on the last day of the course. Grading will be based on class participation, the project paper and a final exam. There will be assigned readings but no midterm or written homework. This course counts as an elective in the Computation, Organizations and Society (COS) Ph.D. program. Topics include: Voting history and administration, vote buying, election rigging, punched cards, optical scanning, DRE machines, paper trails & Internet voting

17-607 Predictable Professional Performance

Intermittent: 9 units

The student will learn to apply the disciplined concepts introduced in PSP by using an agile cyclic development method to create a GUI-based application. While developing the product the student will work in teams to reinforce data collection through a series of ten increments and will learn to estimate using their own data as well as the data of other engineers and will learn to use those estimates to improve their project work. The student will learn how to move quickly through development cycles and will be introduced to shorthand notations for design, learn more about various techniques for development in practice, and will explore technology adoption issues. A special focus will be made on continuous risk management and a more disciplined approach to the capture, analyzing, and making decisions by means of statistical methods. All the techniques, developed interactively with the students, will reinforce the basic concepts from PSP and TSP, but will allow the student to further evaluate their processes and to use the processes in a disciplined team environment with a well understood data collection method. The course will culminate with the student evaluating their own performance as a team member and as a developer in a final report. This course will both reinforce and develop the concepts from PSP and TSP so no prerequisite for either of these courses is needed other than software programming skills producing standalone GUI applications in Java.

17-644 Very Large Information Systems

Fall: 12 units

In this course we cover the basic technology for very large information systems. We cover database and information retrieval file organization, indexes, centralized query processing, concurrency control and serializability theory for transactions. We then consider parallel query processing, distributed query processing, distributed transaction processing, and replication. In the latter part of the course we examine the basics of data warehousing, data mining, publish-subscribe processing, and personal information management. Course material is based on lectures, textbooks, and articles in the literature. Assignments consist of homework, small programming assignments, quizzes and exams. At the end of the course, the student will have a good understanding of the fundamental algorithms used in a broad set of areas of information systems.

17-803 Electronic Voting

Fall: 12 units

After the punched-card disaster in Florida in 2000, the U.S. has been rushing to replace old voting equipment with direct-recording electronic (DRE) machines (sometimes incorrectly lumped together as "touchscreens"). Recent examination of these machines by computer security experts has revealed significant security vulnerabilities, leading to a call by some computer scientists to either discontinue use of such machines or equip them with a printing device that would enable the voter to see a paper record of how she had voted before leaving the voting booth. This "voter-verifiable paper trail" idea has polarized the voting community, leading to bills in Congress and in some states to require it but with vendors, election officials and public advocacy groups strongly in opposition. Each meeting will be devoted to a technical lecture followed by an hour of general discussion. The course is open to juniors, seniors and graduate students. Students from outside SCS are welcome. No advanced technical background is required except for some security and cryptography topics. Each student will participate in a team project, with a presentation to be made on the last day of the course. Grading will be based on class participation, the project paper and a final exam. There will be assigned readings but no midterm or written homework. This course counts as an elective in the Computation, Organizations and Society (COS) Ph.D. program. Topics include: Voting history and administration, vote buying, election rigging, punched cards, optical scanning, DRE machines, paper trails & Internet voting

Electrical & Computer Engineering**18-050 Study Abroad**

Fall: 0 units

18-051 Study Abroad

Spring: 0 units

Students are encouraged to various international collaborative programs offered through the department of Electrical and Computer Engineering.

18-100 Introduction to Electrical and Computer Engineering

Fall and Spring: 12 units

The goals of this freshman engineering course are: * To introduce basic concepts in electrical and computer engineering in an integrated manner; * To motivate basic concepts in the context of real applications; * To illustrate a logical way of thinking about problems and their solutions, and; * To convey the excitement of the profession. These goals are attained through analysis, construction and testing of an electromechanical system (e.g., a robot) that incorporates concepts from a broad range of areas within Electrical and Computer Engineering. Some of the specific topics that will be covered include system decomposition, ideal and real sources, Kirchhoff's Current and Voltage Laws, Ohm's Law, piecewise linear modeling of nonlinear circuit elements, Ideal Op-Amp characteristics, combinational logic circuits, Karnaugh Maps, Flip-Flops, sequential logic circuits, and finite state machines. 3 hrs. lec., 1 hr. rec., 3 hr. lab.
Corequisites: 21-120

18-200 Emerging Trends in Electrical and Computer Engineering

Fall: 1 units

This class consists of a series of individual lectures given by different faculty members and distinguished alumni. The lectures are designed to serve the following purposes: 1) provide students a good understanding of our curriculum structure and the courses in each of our five principle subject areas; 2) introduce to students the emerging trends in electrical and computer engineering and the relevance of our courses; 3) present to students our faculty's research fields; 4) discuss basic learning and working ethics; 5) prepare students career-making skills; 6) introduce new undergraduate courses and research opportunities. The class will contain 12 lectures from faculty members, 2 lectures on learning and working ethics, and 2 lectures from our alumni. Students are required to attend each lecture. An award for the best lecturer, selected by students, will be given at the end of the semester. 1 credit, 1 hr per week, pass/fail, required to graduate. Sophomore standing required.

Prerequisites: 18100

18-202 Mathematical Foundations of Electrical Engineering

Fall and Spring: 12 units

This course covers topics from engineering mathematics that serve as foundations for descriptions of electrical engineering devices and systems. It is the corequisite mathematics course for 18-220, Fundamentals of Electrical Engineering. The topics include: (1) MATLAB as a robust computational tool, used to reinforce, enrich and integrate ideas throughout the course, including software exercises and projects in combination with homework assignments, (2) Complex Analysis, including rectangular and polar representations in the complex plane with associated forms of complex arithmetic, powers, roots and complex logarithms, complex differentiation, analytic functions and Cauchy-Riemann equations, complex Taylor series, complex exponential, sinusoidal and hyperbolic functions, and Euler's formula, (3) Fourier Analysis, including orthogonality of sinusoids, trigonometric and exponential forms of Fourier series, Fourier integrals and Fourier transforms, (4) Linear, Constant-Coefficient Differential Equations, including complex exponential solutions to homogeneous equations and particular solutions with polynomial and sinusoidal driving functions described by phasors, (5) Difference Equations, with emphasis upon their relationship to differential equations, and (6) Linear Algebra and Matrices, including matrix arithmetic, linear systems of equations and Gaussian elimination, vector spaces and rank of matrices, matrix inverses and determinants, eigenvalue problems and their relationship to systems of homogeneous differential equations. 4 hrs. lec., 1hr. rec.

Prerequisites: 21122 or 21118 or 21123

18-220 Fundamentals of Electrical Engineering

Fall and Spring: 12 units

This course covers fundamental topics that are common to a wide variety of electrical engineering devices and systems. The topics include circuit analysis techniques, passive and active components modeling, operational amplifiers, energy storage elements, power analysis, time-response of first- and second-order systems, sinusoidal steady-state response, frequency domain analysis, and filters. Other topics may include: diodes and transistors, basic noise analysis, transformers, pole-zero plotting and analysis in the complex plane. The laboratories are designed to give students the opportunity to build and operate circuits that address specific concepts covered in the lectures, including circuit and component modeling, amplifiers, filters, and signal detection & processing. 3 hrs. lec., 1 hr. rec., 3 hrs. lab.
Prerequisites: 18100 Corequisites: 18-202

18-231 Sophomore Projects

Fall: 1-18 units

The Department of Electrical and Computer Engineering at Carnegie Mellon considers experiential learning opportunities important educational options for its undergraduate students. One such option is conducting undergraduate research with a faculty member. Students do not need to officially register for undergraduate research unless they want it listed on their official transcripts. An ECE student who is involved in a research project and is interested in registering this undergraduate research for course credit on the official transcript may request to be enrolled in this course. To do this, the student should first complete the on-line undergraduate research form available on the ECE undergraduate student page. Once the form has been submitted and approved by the faculty member the student is conducting the research with, the ECE Undergraduate Office will add the course to the student's schedule. Typical credit is granted as one hour of research per week is equal to one unit of credit.

18-232 Sophomore Projects

Spring: 3-18 units

The Department of Electrical and Computer Engineering at Carnegie Mellon considers experiential learning opportunities important educational options for its undergraduate students. One such option is conducting undergraduate research with a faculty member. Students do not need to officially register for undergraduate research unless they want it listed on their official transcripts. An ECE student who is involved in a research project and is interested in registering this undergraduate research for course credit on the official transcript may request to be enrolled in this course. To do this, the student should first complete the on-line undergraduate research form available on the ECE undergraduate student page. Once the form has been submitted and approved by the faculty member the student is conducting the research with, the ECE Undergraduate Office will add the course to the student's schedule. Typical credit is granted as one hour of research per week is equal to one unit of credit.

18-240 Fundamentals of Computer Engineering

Fall and Spring: 12 units

This course introduces basic issues in design and verification of modern digital systems. Topics include: Boolean algebra, digital number systems and computer arithmetic, combinational logic design and simplification, sequential logic design and optimization, register-transfer design of digital systems, basic processor organization and instruction set issues, assembly language programming and debugging, and a hardware description language. Emphasis is on the fundamentals: the levels of abstraction and hardware description language methods that allow designers to cope with hugely complex systems, and connections to practical hardware implementation problems. Students will use computer-aided digital design software and actual hardware implementation laboratories to learn about real digital systems. 3 hr. lec., 1 hr. rec., 3 hr. lab. Prerequisites: 18100 Corequisites: 21-127

18-300 Fundamentals of Electromagnetics

Fall: 12 units

This course introduces electromagnetic principles and describes ways in which those principles are applied in engineering devices and systems. Topics include: vector calculus as a mathematical foundation for field descriptions, Maxwell's equations in integral and differential forms with associated boundary conditions as descriptions of all electromagnetic principles, quasistatic electric fields in free space and in materials, superposition for known charge sources, conduction and polarization, resistance and capacitance, charge relaxation, analytic and numerical methods for electric field boundary value problems, quasistatic magnetic fields in free space and in materials, superposition for known current sources, magnetization, inductance, magnetic diffusion, and analytic and numerical methods for magnetic field boundary value problems. 4 hrs. lec. Prerequisites: 18220

18-310 Fundamentals of Semiconductor Devices

Spring: 12 units

This course replaced 18311 in Spring 2005. In this course you will receive an introduction to the operation and fabrication of the most important semiconductor devices used in integrated circuit technology together with device design and layout. At the end of the course you will have a basic understanding of pn diodes, bipolar transistors, and MOSFETs as well as some light emitting and light detecting devices such as photodiodes, LEDs and solar cells. You will also receive an introduction to the fundamental concepts of semiconductor physics such as doping, electron and hole transport, and band diagrams. In the laboratory you will learn how to lay out both bipolar and MOS devices and you will design small (2-3

transistor) circuits. The laboratory portion of the course emphasizes the relation between device design and layout and circuit performance. You will also experimentally evaluate the operation of amplifier and gate circuits fabricated with discrete devices. This course will give you an excellent understanding of the operation and fabrication of the devices which is necessary for high-performance analog and digital circuit design. 3 hrs. lec., 3 hrs. lab. (Note: the prerequisite is typically waived for MSE students who intend to pursue the Electronic Materials Minor.) Prerequisites: 18220

18-321 Analysis and Design of Analog Circuits

Spring: 12 units

The purpose of this course is to introduce the student to the fundamentals of the analysis and design of basic analog circuits. Topics to be covered include: operational amplifier design, basic amplifier feedback theory, frequency stability and compensation, dc bias calculations and circuits, MOSFET and BJT large- and small-signal device models, small-signal gain and frequency response characteristics of amplifiers, large-signal characteristics and nonidealities. In the hardware laboratory the student will gain experience designing, building, and characterizing analog circuits. The students will also learn how to use the SPICE circuit simulation program to compare actual and simulated performance. The analysis and design of analog circuits incorporating both Bipolar and CMOS technologies will be considered. 3 hrs. lec., 1 hr. rec., 3 hrs. lab. Prerequisites: 18220

18-322 Analysis and Design of Digital Circuits

Fall: 12 units

This course is intended to provide the electrical and computer engineering student with a familiarity to and an understanding of the analytical and computer skills required for the analysis, computer simulation, design, and computer-aided physical layout of digital integrated circuits. This course is preparatory for study in the fields of Very Large Scale Integrated (VLSI) circuits and Computer-Aided Design techniques. The lab focuses on the systematic analysis and design of digital integrated circuits in CMOS technology using CADENCE Design Systems software tools. Prerequisites: 18220 and 18240

18-331 Junior Projects

Fall: 1-18 units

The Department of Electrical and Computer Engineering at Carnegie Mellon considers experiential learning opportunities important educational options for its undergraduate students. One such option is conducting undergraduate research with a faculty member. Students do not need to officially register for undergraduate research unless they want it listed on their official transcripts. An ECE student who is involved in a research project and is interested in registering this undergraduate research for course credit on the official transcript may request to be enrolled in this course. To do this, the student should first complete the on-line undergraduate research form available on the ECE undergraduate student page. Once the form has been submitted and approved by the faculty member the student is conducting the research with, the ECE Undergraduate Office will add the course to the student's schedule. Typical credit is granted as one hour of research per week is equal to one unit of credit.

18-332 Junior Projects

Spring: 3-18 units

The Department of Electrical and Computer Engineering at Carnegie Mellon considers experiential learning opportunities important educational options for its undergraduate students. One such option is conducting undergraduate research with a faculty member. Students do not need to officially register for undergraduate research unless they want it listed on their official transcripts. An ECE student who is involved in a research project and is interested in registering this undergraduate research for course credit on the official transcript may request to be enrolled in this course. To do this, the student should first complete the on-line undergraduate research form available on the ECE undergraduate student page. Once the form has been submitted and approved by the faculty member the student is conducting the research with, the ECE Undergraduate Office will add the course to the student's schedule. Typical credit is granted as one hour of research per week is equal to one unit of credit.

18-340 Digital Computation

Spring: 12 units

In this course we will explore the techniques for designing high-performance digital circuits for computation along with methods for evaluating their properties. We begin by quickly reviewing number systems and digital arithmetic along with basic arithmetic circuits such as ripple-carry adders. We then focus on formal techniques and

theory for analyzing the functionality, timing, power consumption, and chip area properties of these basic circuits and ones yet to be presented. From there, we move to more complex adders (carry-lookahead, carry-skip, carry_bypass, Wallace trees, and hybrid techniques) and multipliers (sequential, array, Booth, and others) along with various divider circuits. Floating point units are then built upon the concepts introduced for adder, multipliers, and dividers. Finally, we will investigate the design and implementation of digital filter circuits. For each circuit introduced, we will develop techniques for evaluating their functionality, their speed, power consumption, and silicon area requirements. In addition, we will utilize various CAD tools to design and evaluate most of the computation circuits discussed. After successful completion of the course, students will not only have an understanding of complex computation circuits, but subtle concepts that include hazards, metastability, false paths, inertial delay, sticky bits, clock skew/jitter, dynamic and static sensitization, and many others. 3 hrs. lec., 1 hr. rec.
Prerequisites: 18240

18-341 Logic Design Using Simulation, Synthesis, and Verification Techniques

Spring: 12 units

The design of digital integrated circuits has grown in complexity to where computer-aided design tools are required for designers to work in an economically productive manner. This course is a study of the techniques of designing the register-transfer and logic levels of complex digital systems using simulation, synthesis, and verification tools. Topics will include memory, bus and communication system interfacing, asynchronous state machines, discrete-event simulation, fault models and test generation, debugging and testbench strategies, and assertion-based verification. Design examples will be drawn from memory systems, bus and communication interfaces, and computation systems, emphasizing how these systems are designed and debugged, and how their functionality can be verified. A modern hardware description language, such as SystemVerilog, will serve as the basis for uniting these topics. Quizzes, homeworks and design projects will serve to exercise these topics.
Prerequisites: 18240

18-342 Fundamentals of Embedded Systems

Fall: 12 units

This practical, hands-on course introduces students to the basic building-blocks and the underlying scientific principles of embedded systems. The course covers both the hardware and software aspects of embedded processor architectures, along with operating system fundamentals, such as virtual memory, concurrency, task scheduling and synchronization. Through a series of laboratory projects involving state-of-the-art processors, students will learn to understand implementation details and to write assembly-language and C programs that implement core embedded OS functionality, and that control/debug features such as timers, interrupts, serial communications, flash memory, device drivers and other components used in typical embedded applications. Relevant topics, such as optimization, profiling, digital signal processing, feedback control, real-time operating systems and embedded middleware, will also be discussed. This course is intended for INI students.
Prerequisites: 18240

18-345 Introduction to Telecommunication Networks

Fall: 12 units

This course introduces the fundamental concepts of telecommunication networks. Underlying engineering principles of telephone networks, computer networks and integrated digital networks are discussed. Topics in the course include: telephone and data networks overview; OSI layers; data link protocol; flow control, congestion control, routing; local area networks (Ethernet, Token Ring and FDDI); transport layer; introduction to high-speed networks; performance evaluation techniques. 4 hrs. lec.
Prerequisites: (15113 or 15123) and 18240 and 36217

18-348 Embedded Systems Engineering

Fall: 12 units

Embedded computing applications far outnumber desktop computers, with billions of microcontrollers produced worldwide each year. Embedded systems vary tremendously, from the single 8-bit processor in a thermostat, to high performance processors in a digital camera, to dozens of networked processors in an automobile. Despite this diversity of applications, there are core technology and system-level skills needed by any embedded system designer that form the content of this course. The emphasis of this course will be at the system layer where hardware meets software, with plenty of hands-on experience at "bare metal" programming. Topics typically covered include embedded computing platforms (hardware, microcontroller instruction sets, software in both assembly language and C); interacting with the external world (analog I/O, serial ports,

control); system-level engineering (design cycle, architectural patterns); real-time operation (timers, interrupts, concurrency); constraints and optimization (economics, power, performance); and a survey of techniques important for building systems that work in the real world (debug, test, robust design, dependability, ethical/societal issues). Weekly hands-on hardware and software experiences with a 16-bit microcontroller module will tie directly to lectures to reinforce core skills. 4 hrs. lec., 1 hr. rec., 3 hrs. lab
Prerequisites: 15213 and 18240

18-349 Embedded Real-Time Systems

Fall: 12 units

This practical, hands-on course introduces the various building blocks and underlying scientific and engineering principles behind embedded real-time systems. The course covers the integrated hardware and software aspects of embedded processor architectures, along with advanced topics such as real-time, resource/device and memory management. Students can expect to learn how to program with the embedded architecture that is ubiquitous in cell-phones, portable gaming devices, robots, PDAs, etc. Students will then go on to learn and apply real-time principles that are used to drive critical embedded systems like automobiles, avionics, medical equipment, the Mars rover, etc. Topics covered include embedded architectures (building up to modern 16/32/64-bit embedded processors); interaction with devices (buses, memory architectures, memory management, device drivers); concurrency (software and hardware interrupts, timers); real-time principles (multi-tasking, scheduling, synchronization); implementation trade-offs, profiling and code optimization (for performance and memory); embedded software (exception handling, loading, mode-switching, programming embedded systems). Through a series of laboratory exercises with state-of-the-art embedded processors and industry-strength development tools, students will acquire skills in the design/implementation/debugging of core embedded real-time functionality.
Prerequisites: 18240 and 15213

18-390 ECE CO-OP

Fall and Spring: 0-3 units

The Department of Electrical and Computer Engineering at Carnegie Mellon considers experiential learning opportunities important educational options for its undergraduate students. One such option is cooperative education, which provides a student with an extended period of exposure with a company. To participate, students must complete an ECE Co-op Approval form (located in HH 1115) and submit for approval. Students must possess at least junior status and have an overall grade point average of 3.0 or above. All co-ops must be approximately 8 months in uninterrupted length. If the co-op is approved, the ECE Undergraduate Studies Office will add the course to the student's schedule. Upon completion of the co-op experience, students must submit a 1-2 page report of their work experience, and a 1-2 page evaluation from the company supervisor to the ECE Undergraduate Office. International students should also be authorized by the Office of International Education (OIE). More information regarding CPT is available on OIE's website.

18-396 Signals and Systems

Fall and Spring: 12 units

This course is a breadth course that also is a prerequisite for most courses in communications, signal processing and control systems. The objective of this course is to provide students with an integrated understanding of the relationships between mathematical tools and properties of real signals and systems. This is accomplished by motivating lectures and recitation problems using demonstrations and laboratory assignments which cover such topics as radio transmission and reception, audio synthesizers, CDs, image processing, and prosthetic devices. In the course of the semester, students are introduced to industry-standard computing and simulation tools that will be used in subsequent courses. Continuous and discrete-time signals and systems are treated in a unified manner through the concept of sampling. The course covers the basic concepts and tools needed to perform time and transform domain analyses of signals and linear time-invariant systems, including: unit impulse response and convolution; Fourier transforms and filtering; Laplace transforms, feedback and stability; and a brief introduction to z-transforms in the context of digital filtering.
Prerequisites: 18202 and 18220

18-401 Electromechanics

12 units

This course provides a broadly based introduction to interactions between mechanical media and electromagnetic fields. Attention is focused on the electromechanical dynamics of lumped-parameter systems, wherein electrical and mechanical subsystems may be modeled in terms of discrete elements. Interactions of quasistatic electric and magnetic fields with moving media are described

and exemplified. Unifying examples are drawn from a wide range of technological applications, including energy conversion in synchronous, induction, and commutator rotating machines, electromechanical relays, a capacitor microphone and speaker, and a feedback-controlled magnetic levitation system. 4.5 hrs. rec.
Prerequisites: 18300

18-402 Applied Electrodynamics
Spring: 12 units

This course builds upon the electric and magnetic field foundations established in 18-300 to describe phenomena and devices where electromagnetic waves are a central issue. Topics include: review of Maxwell's equations, propagation of uniform plane waves in lossless and lossy media, energy conservation as described by the Poynting Theorem, reflection and transmission with normal and oblique incidence upon boundaries, sinusoidal steady state and transients on 2-conductor transmission lines, modal descriptions of waveguides, radiation and antennas. 4 hrs. lec.
Prerequisites: 18300

18-410 Physical Sensors, Transducers and Instrumentation
Spring: 12 units

While modern electronic circuits have become largely digital, the physical world, and consequently, the electronic interface to the physical world remains fundamentally analog. Therefore, sensors, transducers, and the initial signal processing remain in the analog domain. Simultaneously, the commercial market place optimizes sensor technology based upon multiple attributes including cost, detectivity, size, speed, etc. In this course we explore both the many types of possible responses to various physical stimuli, as well as the instrumentation, electronic detection, signal conversion and signal processing techniques used to bring the physical event into the electronic world in a practical manner. This requires that we learn about the diversity of physical phenomena, materials and devices that can be used to convert the various forms of physical energy into electronic signals. Due to the significant diversity of physical phenomena the course requires reading from textbooks, the technical literature and patent literature. The course is taught via the case method with student participation via oral and written reports. The student should arrive with a strong interest in, and basic understanding of, physics, material science, chemistry and analog electronic circuits as taught at the sophomore and junior course level.

Prerequisites: 18300 or 18303 or 18310 or 18311 or 18321 or 27432

18-411 Computational Techniques in Engineering
Spring: 12 units

This course develops the methods to formulate basic engineering problems in a way that makes them amenable to computational/numerical analysis. The course will consist of three main modules: basic programming skills, discretization of ordinary and partial differential equations, and numerical methods. These modules are followed by two modules taken from a larger list: Monte Carlo-based methods, molecular dynamics methods, image analysis methods, and so on. Students will learn how to work with numerical libraries and how to compile and execute scientific code written in Fortran-90 and C++. Students will be required to work on a course project in which aspects from at least two course modules must be integrated.
Prerequisites: 15100 and 21120 and 21122 and 21259 and 21260

18-412 Field Effect Devices and Technology
Fall: 12 units

This course follows 18-310, which provides an introduction to the physics of semiconductor devices. 18-412 addresses in detail the physics of semiconductor devices which work on the field effect principle, which are today technologically and economically dominant. These devices include the MOSFET, junction field effect devices (JFET and MESFETs), thin film field effect transistors (TFTs), and related devices. The course material is specifically motivated by current applications in which portable and low power operation is required. Particular applications which are discussed in detail include scaled MOSFETs for logic and memory; CCD imagers; active matrix flat panel displays; and MESFETs for digital and RF applications. This semester: The evolution continues, this course increasingly will incorporate more content on semiconductor process technology. I believe that an increasing degree of understanding of processing and its limitations is needed in order to make sense of current issues in device physics. There will be several lectures on process technology at the beginning of the course. This is the result of an evolving convergence of this course with my graduate processing course 18-815, (not expected to be offered in the near future).
Prerequisites: 33107 and (18310 or 18311)

18-413 Introduction to Computer-Aided Instrumentation and Characterization
Intermittent: 12 units

This course introduces students to the use of Labview, a commonly used tool for instrument control. In addition, a number of essential aspects of measurement hardware and measurement technology will be studied. Students will develop a fundamental understanding of important issues encountered in instrumentation and device characterization, including accuracy, resolution, noise, parasitics, and grounding that will enable students to critically assess their data and to rapidly develop solutions to new measurement problems. In addition, this course will encourage a systematic approach to the development of instrument control software, including overall planning, partitioning into testable and reusable pieces, incorporation of error detection and error handling, and provision of a user-friendly interface.

Prerequisites: 18310 or 18311 or 18321

18-415 From Design to the Market for Deep Submicron IC's
Spring: 12 units

The general objective of the 18-415 class is to introduce and analyze all major design-dependent trade-offs which decide about the IC product commercial success. This objective will be achieved via playing in the class an "imaginary fabless IC design house startup game"- a main class activity. In this game students will be asked to construct "business plans" for a startup fabless IC design house. Each team in the class will have to envision, as an IC design objective, a new product with a functionality, which is already provided by another existing IC product (i.e. by microprocessor). The envisioned product should provide a subset of functionality of the existing product but it should be "better" in some other respect (e.g. it could be less expensive to fabricate, faster etc.). To handle the above assignment, students in the class will be using skills learned in 18-322 as well as all legal sources of "industrial intelligence" typically available for the IC industry. They can also use the class teacher as a source of free consulting, as well as, they can ask for any sequence of lectures or literature sources which they will need to meet the class objectives.

Prerequisites: 18322

18-416 Data Storage Systems
Fall: 12 units

This course teaches the fundamentals of magnetic and optical recording technology as used in data storage systems, audio and video recording. It begins with a treatment of systems considerations, including data rate, storage capacity, and formats of various tape and disk systems. It then moves on to treat the details of the writing and readback processes including descriptions of the heads and media. The concepts in magnetic materials and electromagnetics required to understand these devices are also covered. Lectures and problem sets are supplemented by six laboratories in which students record, readback, analyze actual signals, and operate magnetic and magnetoresistive devices. 3.0 hrs. lec., 3.0 hrs. lab (meets six times).
Prerequisites: 18300 or 18310

18-417 Optical Communications Systems
Fall: 12 units

(Formerly 18-315.) In this course, students will receive an introduction to the fundamental principles and components of optical communications. The course objective is to provide a basic understanding of present optical communication systems as well as future engineering challenges. The course covers the basic concepts of data modulation in optical fiber channels, channel multiplexing, wavelength division multiplexing, and fiber optics. The course also includes the basic function principles of optical fiber, light emitting diodes, lasers, optical amplifiers, optical filters, and optical receivers. 3 hrs. lec., 1 hr rec.
Prerequisites: 18310

18-418 Electric Energy Processing: Fundamentals and Applications
Fall: 12 units

This course provides an introduction to the fundamentals of electric energy conversion, and its use in several real-life electric energy systems. The course starts with a brief review of electromagnetic and electromechanical conversion underlying electric power generation. The first part of the course introduces basic components found in today's electric energy systems, such as 1) electric machines (generators and motors), 2) power electronics for converting between AC and DC portion of an electric energy system, and 3) control of these components for their efficient use. The principles underlying design, operations and control of these components are introduced using conversion fundamentals and basic electric circuit knowledge. The second part of this course introduces several key electric energy systems used in today's industry.

Examples of such systems are 1) home distribution electric power systems; 2) electric power systems for vehicles; 3) electric power systems for ships; and 4) airspace electric power systems (such as airplanes and space shuttles). This course provides an important bridge between the applied physics and the systems areas in the ECE. It is intended to bring out the fact that it is electric energy and its conversion that underlies much of what one does in ECE.
Prerequisites: 18220

18-419 Electron Device Physics

Fall: 12 units

In 18-419 we discuss some of the most important modern electronic and optoelectronic devices, including a variety of field effect transistors, resonant tunneling devices, and light-emitting devices, etc. This course builds upon the foundation of semiconductor device physics covered in 18-310. It provides in depth analysis on critical physical aspects that determine the performance of the devices. A special focus will be on major scientific and technological issues in the scaling of semiconductor systems into deep nanometer regime. In addition, this course introduces several recently emerged novel nanoscale electronic devices that are based on nonconventional nanoscale materials. Some of these device systems are currently being considered for potential applications in future nanoelectronics. Relating to this topic, the course also presents a basic introduction to quantum physics which fundamentally governs the properties of deep-nanoscale electronic systems; and a brief review on state-of-art nano-fabrication technology.
Prerequisites: 18310

18-431 Undergraduate Projects - Senior

Fall: 1-18 units

The Department of Electrical and Computer Engineering at Carnegie Mellon considers experiential learning opportunities important educational options for its undergraduate students. One such option is conducting undergraduate research with a faculty member. Students do not need to officially register for undergraduate research unless they want it listed on their official transcripts. An ECE student who is involved in a research project and is interested in registering this undergraduate research for course credit on the official transcript may request to be enrolled in this course. To do this, the student should first complete the on-line undergraduate research form available on the ECE undergraduate student page. Once the form has been submitted and approved by the faculty member the student is conducting the research with, the ECE Undergraduate Office will add the course to the student's schedule. Typical credit is granted as one hour of research per week is equal to one unit of credit.

18-432 Senior Projects

Spring: 1-42 units

The Department of Electrical and Computer Engineering at Carnegie Mellon considers experiential learning opportunities important educational options for its undergraduate students. One such option is conducting undergraduate research with a faculty member. Students do not need to officially register for undergraduate research unless they want it listed on their official transcripts. An ECE student who is involved in a research project and is interested in registering this undergraduate research for course credit on the official transcript may request to be enrolled in this course. To do this, the student should first complete the on-line undergraduate research form available on the ECE undergraduate student page. Once the form has been submitted and approved by the faculty member the student is conducting the research with, the ECE Undergraduate Office will add the course to the student's schedule. Typical credit is granted as one hour of research per week is equal to one unit of credit.

18-447 Introduction to Computer Architecture

Fall and Spring: 12 units

Computer architecture is the science and art of selecting and interconnecting hardware components to create a computer that meets functional, performance and cost goals. This course introduces the basic hardware structure of a modern programmable computer including, the basic laws underlying performance evaluation. We will learn, for example, how to design the control and data path hardware for a MIPS-like processor, how to make machine instructions execute simultaneously through pipelining and simple superscalar execution, and how to design fast memory and storage systems. The principles presented in lecture are reinforced in the laboratory through design and simulation of a register transfer (RT) implementation of a MIPS-like pipelined superscalar in Verilog. Learning to design programmable systems requires that you already have the knowledge of building RT systems as is taught in the prerequisite 18-240, the knowledge of the behavior storage hierarchies (e.g., cache memories) and virtual memory as is

taught in the prerequisite 15-213, and the knowledge of assembly language programming as is taught in the prerequisites. 3 hrs. lec., 3 hrs. lab.

Prerequisites: 15213 and 18240

18-450 Digital Wireless Communications

Fall: 12 units

In this course, wireless communication channels will be introduced, and their peculiarities such as fading and co-channel interference will be emphasized. Solutions to combat the problems will be described, covering equalization and detection, coding and diversity ideas. Throughout the course, the emphasis will be on discovering unifying ideas in transmission, rather than specifying the details of each application. Illustrative examples will be chosen from existing wireless standards (e.g. W-CDMA). A course project on designing a wireless transceiver simulation model, based on MATLAB, will enhance understanding of the underlying theory. Lab demonstrations will be used to show practical applications of the theory. Possible research directions will be pointed out, for students interested in a more detailed understanding. The course will also cover basic communication theory in sufficient detail. 18-450 is a pre-requisite for graduate-level wireless communication courses. 4 hrs. lec.
Prerequisites: 18396 and 36217

18-470 Fundamentals of Control

Fall: 12 units

An introduction to the fundamental principles and methodologies of classical feedback control and its applications. Emphasis is on problem formulation and the analysis and synthesis of servomechanisms using frequency and time domain techniques. Topics include analytical, graphical, and computer-aided (MATLAB) techniques for analyzing and designing automatic control systems; analysis of performance, stability criteria, realizability, and speed of response; compensation methods in the frequency domain, root-locus and frequency response design, and pole-zero synthesis techniques; robust controller design; systems with delay and computer control systems; transfer function and state space modeling of linear dynamic physical systems; nonlinearities in control systems; and control engineering software (MATLAB). 4 hrs. lec., 1 hr. rec.
Prerequisites: 18396

18-474 Embedded Control Systems

Spring: 12 units

This course introduces principles for design of embedded controllers. In applications ranging from airplanes, to automobiles, to manufacturing systems, embedded computers now close feedback loops that were previously closed by mechanical devices or by humans in the loop. This course emphasizes practical insight into the tools for modeling and simulating these dynamic physical systems, and methods for designing the real-time software for embedded computers to control them. Lectures cover relevant theory and background from real-time systems and control engineering, including event-based and clock-based sampling, switching control, PWM (pulse-width modulation), PID (proportional-integral-derivative) design, state-variable feedback, state estimation, and methods for setpoint control and trajectory tracking. Basic embedded computing, sensor, and actuator technologies are reviewed, including microcontrollers, DC motors and optical encoders. In the laboratory, students use commercial tools for simulation and automatic code generation to design and implement embedded control system experiments. 3 hrs. lecture, 3 hrs. lab.
Prerequisites: 18396

18-482 Telecommunications, Technology Policy & Management

Fall: 12 units

This course provides a comprehensive introduction to basic principles of telecommunications technology and the telephone network, and the legal, economic, and regulatory environment of the telecommunications industry. Role of new technologies such as fiber, integrated digital networks, computer communications, and information services. Common carrier law and the economics of natural monopoly as the basis for regulation of the telecommunications industry. Issues of competition, monopoly and technical standards. Spectrum allocation and management. International communications and transborder data flow. Special emphasis on how the new technologies have altered and are altered by regulation. Junior or Senior standing required.
Prerequisites: 73100

18-487 Introduction to Computer & Network Security & Applied Cryptography

Spring: 12 units

Security is becoming one of the core requirements in the design of critical systems. This course will introduce students to the intro-

level fundamental knowledge of computer security and applied cryptography. Students will learn the basic concepts in computer security including software vulnerability analysis and defense, networking and wireless security, and applied cryptography. Students will also learn the fundamental methodology for how to design and analyze security critical systems.
Prerequisites: 15213

18-491 Digital Signal Processing
Spring and Summer: 12 units

This course addresses the mathematics, implementation, design and application of the digital signal processing algorithms widely used in areas such as multimedia telecommunications and speech and image processing. Topics include discrete-time signals and systems, discrete-time Fourier transforms and Z-transforms, discrete Fourier transforms and fast Fourier transforms, digital filter design and implementation, and multi-rate signal processing. The course will include introductory discussions of 2-dimensional signal processing, linear prediction, adaptive filtering, and selected application areas. Classroom lectures are supplemented with implementation exercises using MATLAB.
Prerequisites: 18396

18-492 Special Topics: Speech Processing
Fall: 12 units

Speech Processing offers a practical and theoretical understanding of how human speech can be processed by computers. It covers speech recognition, speech synthesis and spoken dialog systems. The course involves practicals where the student will build working speech recognition systems, build their own synthetic voice and build a complete telephone spoken dialog system. This work will be based on existing toolkits. Details of algorithms, techniques and limitations of state of the art speech systems will also be presented. This course is designed for students wishing understand how to process real data for real applications, applying statistical and machine learning techniques as well as working with limitations in the technology.

18-493 Electroacoustics
Fall: 12 units

This course provides an introduction to physical, engineering, and architectural acoustics. The course begins with a review of the wave equation and some of its solutions that are relevant to the propagation of sound from planar and spherical sources, and from arrays of simple sources. Lumped-parameter electrical circuit analogies are developed to describe mechanical and acoustical systems, leading to a discussion of the constraints and tradeoffs involved in the design of loudspeakers, microphones, and other transducers. The characteristics of sound in regular and irregular enclosures will be developed and discussed in the context of the acoustical design for rooms and auditoriums. The interaction of sound and man is also discussed, with introductory lectures on auditory perception and the acoustics of speech production, with applications in the areas of efficient perceptually-based coding of music and speech, and virtual acoustical environments.
Prerequisites: 18220

18-496 Introduction to Biomedical Imaging and Image Analysis
Fall: 12 units

Bioimage Informatics (formerly Bioimaging) This course gives an overview of tools and tasks in various biological and biomedical imaging modalities, such as fluorescence microscopy, electron microscopy, magnetic resonance imaging, ultrasound and others. The major focus will be on automating and solving the fundamental tasks required for interpreting these images, including (but not restricted to) deconvolution, registration, segmentation, pattern recognition, and modeling, as well as tools needed to solve those tasks (such as Fourier and wavelet methods). The discussion of these topics will draw on approaches from many fields, including statistics, signal processing, and machine learning. As part of the course, students will be expected to complete an independent project.
Prerequisites: 18290 or 18396

18-499 Internship
All Semesters: 0-3 units

The Department of Electrical and Computer Engineering at Carnegie Mellon considers experiential learning opportunities important educational options for its undergraduate students. One such option is an internship, normally completed during the summer. Students do not need to officially register for an internship unless they want it listed on their official transcripts. ECE students interested in registering their internship for course credit on their transcript may request to be enrolled in this course. The ECE Undergraduate Office will add the course to the student's schedule, and the student will be assessed tuition for 3 units. This process should be used

by international students interested in Curricular Practical Training (CPT) or by any other engineering undergraduate wishing to have their internship experience reflected on their official University transcript. International students should also be authorized by the Office of International Education (OIE). More information regarding CPT is available on OIE's website.

18-513 RF Circuits and Antennas for Wireless Systems
Fall: 12 units

The demand for wireless products is growing at an impressive rate. This interdisciplinary course will team students from electromagnetics with students from analog circuit design to explore the concepts of basic antenna design and measurement as well as RF transceivers. The students will have the opportunity to design and build transmitter or receiver sub-systems, based on their application of interest. Designs may be done with discrete components for AM, FM and VHF (TV) receptions or with integrated components for UHF applications, such TV, wi-fi, etc. Integrated with these efforts will be the design of several types of widely used antennas. Students will design, construct, and test an antenna to meet stated specifications using a combination of theory, electromagnetic simulators and lab experiments. The focus of this course will be the construction of an antenna/tranciever system. In addition to the project, several lectures will be given to introduce students to the specific applications and to consolidate previous course materials as they apply to the project.
Prerequisites: (18300 and 18321) OR 18402

18-517 Data Storage Systems Design Project
Spring: 12 units

This course gives students a comprehensive understanding of data storage systems through lecture and simulation exercises. Over the course of the semester, students will work in teams to build a computer simulation of an entire disk drive recording channel, and observe the different forms that the stored information takes on its passage through a non-volatile storage system. As many realistic aspects of the storage system will be incorporated in the simulation as possible, including magnetic media hysteresis, magnetic and electronic noise, magnetoresistive readback sensors, and various methods of data detection. The class will culminate with demonstrations by each group of their models, and the effect the changes in recording parameters have on data integrity. Currently the SIMULINK package is used with Matlab to construct the simulation, and students are provided with a 3 hr. recitation period each week during which they can work on their simulation under the supervision of the course instructors. 3 hrs. lecture, 3 hrs. rec. Graduate students may have the pre-requisites waived.
Prerequisites: 18416 or (18316 and 18396) or (18300 and 18396) or (18310 and 18396)

18-525 Integrated Circuit Design Project
Spring: 12 units

This course is intended to provide the electrical and computer engineering student with IC design experience. The primary stress of the 18-525 class will be on the IC design process as a whole. Such a process, seen as a sequence of design decisions, must lead to a design which optimizes a given objective function under a number of constraints. The optimum design must be achieved using a number of variables involving all levels of design abstraction and ranging between architecture choice and detail of the IC layout. Typical design objectives adopted in 18-525 designs will be IC performance (throughput, power, signal-to-noise ratio, clock frequency, gain-bandwidth, etc.) and typical constraints will be die size and minimum feature size. The second most important objective of 18-525 is to mimic a large design team environment in which individual designers must: (a) communicate precisely and efficiently his/her ideas and (b) utilize any feedback provided by the "design environment". This objective will be achieved through class presentations given by each student and by stressing the importance of design documentation. 4 hrs. class.
Prerequisites: 18322 AND (18340 or 18341 or 18321 or 18310 or 18450 or 18491 or 18415)

18-540 Rapid Prototyping of Computer Systems
Spring: 12 units

This is a project-oriented course which will deal with all four aspects of project development; the application, the artifact, the computer-aided design environment, and the physical prototyping facilities. The class, in conjunction with the instructors, will develop specifications for a mobile computer to assist in inspection and maintenance. The application will be partitioned between human computer interaction, electronics, industrial design, mechanical, and software components. The class will be divided into groups to specify, design, and implement the various subsystems. The goal is to produce a working hardware/software prototype of the system

and to evaluate the user acceptability of the system. We will also monitor our progress in the design process by capturing our design escapes (errors) with the Orthogonal Defect Classification (ODC). Upon completion of this course the student will be able to: generate systems specifications from a perceived need; partition functionality between hardware and software; produce interface specifications for a system composed of numerous subsystems; use computer-aided design tools; fabricate, integrate, and debug a hardware/software system; and evaluate the system in the context of an end user application. Senior standing is required.
Prerequisites: 18348 or 18349 or (18322 and 18396) or (18322 and 18340) or (18322 and 18341) or (18396 and 18340) or (18396 and 18341)

18-544 Network Design and Evaluation
Fall: 12 units

The purpose of the "Network Design and Evaluation" is to give students hands-on experience building networking software. A typical project will be the design, implementation, and evaluation of a network protocol. The design will specify the requirements, protocol specification, and success criteria. The implementation will have to work over an actual network, and the evaluation will evaluate whether the success criteria have been met. Students will work in teams and will have a choice of a small number of projects.
Prerequisites: 15213 and (18345 or 15441)

18-545 Advanced Digital Design Project
Fall: 12 units

In this capstone design project course, students will design and implement a large digital system with video output, sound output, and user input. The course will teach the technical skill to accomplish this, as well as enhance project planning and group management skills. To that end, students will participate in design reviews, weekly status reports, and final project presentations. The project will result in a working system implemented on an FPGA prototyping board. The completed projects will be shown in a public demonstration session at the end of the semester. Students should enter with a good grasp of computer architecture, Verilog programming, and hardware lab skills. Experience in FPGA programming, computer graphics, and/or VLSI design would also be useful.
Prerequisites: 18447 OR (18340 and 15213) OR (18341 and 15213)

18-549 Embedded Systems Design
Fall: 12 units

This course comprises a semester-long project experience geared towards the development of skills to design realistic and practical embedded systems and applications. Students will work in teams on an innovative project that will involve the hands-on design, configuration, engineering, implementation and testing of a prototype of an embedded system of their choice. Students will be expected to leverage proficiency and background gained from other courses, particularly with regard to embedded real-time principles and embedded programming. The project will utilize a synergistic mixture of skills in system architecture, modular system design, software engineering, subsystem integration, debugging and testing. From inception to demonstration of the prototype, the course will follow industrial project practices, such as version control, design requirements, design reviews and quality assurance plans. The initial lecture content will cover background material intended to complement the project work. The remainder of the course will consist of regular team presentations of key project milestones, current project status, a final project presentation and functional demonstrations of various subsystems, even as the entire prototype is being developed. Please refer to the course website for more information: <http://www.ece.cmu.edu/~ece549/>
Prerequisites: 15410 or 18348 or 18349

18-551 Digital Communication and Signal Processing Systems Design
Fall: 12 units

This course provides the student with a rich, in-depth design and application hardware project experience in the areas of digital communications and/or signal processing systems using DSP hardware. Teams of students work on a semester-long project of their choice. Topics include: speech and music processing, digital communications, multimedia processing, data compression, data storage, wireless communications, CD, image and/or signal processing, etc. One month of introductory laboratories familiarize the students with DSP hardware and support software. Lectures address z-transforms, IIR and FIR filter design using MATLAB and DSP hardware, LPC and adaptive filters, channel coding, time and frequency multiplexing, short time Fourier and wavelet transforms, and spread spectrum techniques. 4 hrs. lec., 3 hrs. lab.
Prerequisites: 18396 and (15211 or 18450 or 18791 or 18792 or 18793 or 18795 or 18796 or 18798)

18-578 Mechatronic Design

Spring: 12 units
Mechatronics is the synergistic integration of mechanism, electronics, and computer control to achieve a functional system. Because of the emphasis upon integration, this course will center around system integration in which small teams of students will configure, design, and implement a succession of mechatronic subsystems, leading to a main project. Lectures will complement the laboratory experience with comparative surveys, operational principles, and integrated design issues associated with the spectrum of mechanism, electronics, and control components. Class lectures will cover topics intended to complement the laboratory work, including mechanisms, actuators, motor drives, sensors and electronic interfaces, microcontroller hardware and programming and basic controls. During the first week of class, each student will be asked to complete a questionnaire about their technical background. The class will then be divided into multi-disciplinary teams of three students. During the first half of the class, lab assignments will be made every 1-2 weeks to construct useful subsystems based on material learned in lecture. The lab assignments are geared to build to the main project. This course is cross-listed as 16-778 and 24-778. Students in other departments may take the course upon availability of slots with permission of instructor. Non ECE students may take the course upon availability of slots with permission of the instructor.
Prerequisites: 18348 or 18370 or 18470 or 18474 or 18349 or (18321 and 18396)

Engineering & Public Policy

19-101 Introduction to Engineering and Public Policy
Spring: 12 units

This course examines the processes of public and private decision making and of policy formation, which shape the evolution of a technology and its impact on our society. Technology plays an important role in shaping our worlds. At the same time, social forces often play a central role in the evolution of a technology. A particular technology such as an automobile or computer is chosen to study technology and policy in context. Specific topics covered in the case of the automobile includes automotive design and manufacture, safety, pollution, fuel economy and their interactions. In each area, we discuss the technological and institutional issues, their interaction, the possible need for public policy and the factors that govern the policy. The course will involve several group problem-solving sessions.
Corequisites: 21-115, 21-116, 33-106

19-102 EPP Sophomore Seminar
Fall: 3 units

The Sophomore Seminar has the objective of introducing the student to the interdisciplinary nature of Engineering and Public Policy problems. This is achieved through the use of case studies dealing with aspects of decision-making and ethics in policy issues which have a technological basis. Students are introduced to the technical and policy dimensions of these problems as well as to skills such as data collection and analysis, group work, and oral and written presentations. A few seminars by EPP graduates and faculty are occasionally included to give the student an idea of careers and EPP problems.

19-402 Telecommunications, Technology Policy & Management
Intermittent: 12 units

This course provides a comprehensive introduction to basic principles of telecommunications technology and the legal, economic, and regulatory environment of the telecommunications industry. Topics covered are: role of new technologies such as fiber, wireless, voice over packet, and broadband access; principles behind telecommunications regulation from common carrier law and natural monopoly to open access and interconnection; differences in the treatment of telecommunications versus information services. Also, mergers, antitrust, and the changing industrial structure of telecommunications; spectrum allocation and management; and international comparison of telecommunications regulations. Special emphasis on how the new technologies have altered and are altered by regulation.
Prerequisites: 73100

19-424 Energy and the Environment
Intermittent: 9 units

This course will explore the relationships between environmental impacts and the utilization of energy through a series of case studies on topics of current interest. Such topics might include the use of renewable and non-renewable fuels for electric power generation; energy use for automobiles and other transportation systems; energy use for buildings and industrial processes; and

environmental issues such as urban air pollution, ozone formation, acid rain, and global warming. The emphasis will be on analysis of energy-environmental interactions and tradeoffs, and their dependency upon engineering design choices, economic variables, and public policy parameters.

19-426 Environmental Decision Making

Intermittent: 9 units

This course will cover a number of topics in environmental decision making, including risk perception, risk communication, risk ranking, multi-attribute utility theory, decision analysis, the "precautionary principle," the economics of environmental externalities, commons dilemmas, cost-benefit analysis, the valuation of health and environmental amenities, discounting, intergenerational equity, environmental justice, and sustainability.

19-430 Civilian and Military Applications of Space

Intermittent: 12 units

An analysis of some specific defense and space policy issues is conducted. This analysis is abstracted from a study of the specific technologies involved. An assessment of the impact of technological advancement on the military capability, space policy and arms control issues is proposed. As the exploitation of high technology has a lot of ramifications, the course focuses on some areas carefully chosen, based on the recent events, to illustrate the extent of the impact and to permit as wide-ranging a discussion as possible. Those issues cover areas of advanced imaging and target recognition capabilities; the military exploitation of new physical principles; the development of new capabilities in space for military or civilian exploitation, and the convolution of these new capabilities with the increasing technological demands of arms control. In all examples, the interaction between technological progress and needs for policy changes (or emergence of policy dilemmas) are emphasized.

19-440 Combustion and Air Pollution Control

Intermittent: 9 units

Formation and control of gaseous and particulate air pollutants in combustion systems. Basic principles of combustion, including thermochemical equilibrium, flame temperature, chemical kinetics, hydrocarbon chemistry, and flame structure. Formation of gaseous and particulate pollutants in combustion systems. Combustion modifications and postcombustion technologies for pollutant control. Relationship between technology and regional, national, and global air pollution control strategies. The internal combustion engine and coal-fired utility boiler are used as examples.

19-448 Science, Technology & Ethics

Intermittent: 9 units

Technology has always been a pervasive force in society. But the last century, and especially the last 50 years have seen an unprecedented acceleration of the growth and permeation of technology. The central role of technology and engineering in the modern world calls for a reflective examination of the responsibility of those who develop, deploy and spread technologies as well as those who avail of them for various purposes. This course will explore one technology of recent origin in detail – biotechnology. After examining the way people think about and deal with technological risk, the basic science behind the technology and the ethos of science and technology, the students will learn about the philosophical foundations of possible ethics for science and technology. Projects and discussions will explore how these foundations can be used to provide ways to frame important questions and develop an understanding of an ethic for the development and use of biotechnology.

19-451 EPP Projects

Spring: 12 units

Interdisciplinary problem-solving projects in which students work as leaders or members of project teams. Problem areas are abstracted from local, state and national situations and involve the interaction of technology and public policy, with different projects being chosen each semester. Oral and written presentations concerning the results of project studies are required.

19-452 EPP Projects

Fall: 12 units

Interdisciplinary problem-solving projects in which students work as leaders or members of project teams. Problem areas are abstracted from local, state and national situations and involve the interaction of technology and public policy, with different projects being chosen each semester. Oral and written presentations concerning the results of project studies are required.

19-500 Directed Study in EPP: Undergraduate

All Semesters: 0-12 units

Students may do undergraduate research as one course for EPP technical elective credit, with an EPP faculty member, or on an approved project with a faculty member from another department. The research credits must be pre-approved by your advisor, and should result in a written product, one copy of which should be sent to EPP.

19-601 Information Warfare

Intermittent: 12 units

Information security is one major concern raised by the increasing use of computers in networks. In this course we first review, in some technical detail, the nature of the "threats". These include viruses and worms (their history and how they "evolved"), backdoor exploits, Trojan horses, buffer overflows, and the extent to which they imperil the information in computers. Then we discuss the use and limitations of firewalls in protecting computer networks. We also discuss intrusion detection and the problems associated with it. We review past and present cyberattacks, like Denial of Service attacks, viruses such as Melissa and I love you, and assess their implications. We analyze the origin of computer vulnerabilities which make those attacks possible and discuss the extent to which they could be reduced. Finally, we analyze the response to this situation at the national, security and international level.

19-606 Special Topics: Civil Systems Investment Planning and Pricing

Intermittent: 12 units

Economic framework for identifying and analyzing investment and operation options facing agencies and firms, (both in theory and in practice); economic efficiency, utilization, pricing, and investment; and multi-objective evaluation.

19-609 Public Policy and Regulation

Intermittent: 9 units

Regulations are a significant policy tool of government. How society and the economy will react to new regulations can be hard to predict. Unintended side effects sometimes occur resulting in costs exceeding estimates and/or benefits never being realized. This course will review the basics of regulatory policy and using historical examples, will explore the reasons why past regulations have succeeded and failed. The second half of the course will involve 2-3 detailed case studies. Quantitative methods will be used to evaluate several pending regulations for real-world clients from both government and industry perspectives. Prerequisites: Basic statistics, economics, and quantitative methods

19-614 Environmental Life Cycle Assessment and Green Design

Spring: Mini Session - 6 units

Cradle-to-grave analysis of new products, processes and policies is important to avoid undue environmental harm and achieve extended product responsibility. This mini-course provides an overview of approaches and methods for life cycle assessment and for green design of typical products and processes. Process-based analysis models, input-output and hybrid approaches are presented for life cycle assessment. Example software programs are used in assignments. A life cycle assessment project is required. Prerequisite: senior standing in engineering or permission of the instructor.

19-616 Case Studies in Sustainability Engineering

Spring: Mini Session - 6 units

The principles and tools of sustainability have yet to be applied on a large scale to solving real-world engineering problems. In this course, we explore the use of these principles and tools to various case studies. Prerequisites: 12712 or 12714 or 19614 or 19622

19-622 Introduction to Sustainable Engineering

Fall: Mini Session - 6 units

Society has generally assumed that the earth's resources are limitless and wastes can be disposed of without serious consequences, but the validity of these assumptions is now being challenged. This course begins with an overview of the concept of sustainability and its history, including changing attitudes and values toward technology and the environment through the twentieth century. Key conferences and reports that helped define sustainability are reviewed. Models for population growth, global food production, and global water resources are then presented, and current problems of land use, urbanization, and energy and material resources are discussed. Overall, the course material provides a context for engineering decisions in the twenty-first century, which are quite different from decisions of engineers in the past. Prerequisite: senior standing in engineering or permission of the instructor.

19-623 Industrial Ecology and Sustainable Engineering Design

Fall: Mini Session - 6 units

This course uses the context established in 12-712 / 19-622 to explore the solution space of engineers in tackling basic problems facing human civilization. The course begins with the concept of a system, using the earth's life support systems as examples. The potential damage of conventional engineering decisions on these life support systems is discussed. Models of industry based on life sciences are then explored, and tools for sustainable engineering are presented. These tools include metrics of sustainability, principles of design for the environment, methods for pollution prevention, and use of mass and energy balances in the design of sustainable systems. Finally, the principles and tools of sustainable engineering are used to explore solutions to some of the most challenging problems identified in 12-712 / 19-622.

Prerequisites: 12712 or 19622

19-644 Medical Devices

Intermittent: 9 units

This course is an introduction to the engineering, clinical, legal and regulatory aspects of medical device performance and failure. Topics covered include phenomenological and mechanistic descriptions of processes such as wear, corrosion fatigue and fretting, in addition to the characterization of bone and other biological materials as it relates to device performance requirements, including biocompatibility. The course also involves case studies of orthopedic fixation devices and prostheses, pacemakers, heart valves and artificial organs. A major portion of the course is a final design project which involves the design of a new medical device or the redesign of an existing device.

Mathematical Sciences**21-101 Freshman Mathematics Seminar**

Fall: Mini Session - 3 units

This course is offered in the second half of the Fall semester for first semester Freshmen interested in majoring in mathematics. Topics vary from year to year. Recent topics have been finite difference equations, convexity, and fractals. 3 hrs. lec.

21-105 Pre-Calculus

Fall: 9 units

Review of basic concepts, logarithms, functions and graphs, inequalities, polynomial functions, complex numbers, and trigonometric functions and identities. 3 hrs lec., 1 hr.rec.

21-106 Co-Calculus

Fall: Mini Session - 2 units

A review of the basic skills needed for success in calculus and other science and engineering courses with a focus on problem solving skills, basic algebra, and inequalities. To be taken concurrently with 21-120. 2 hours lecture, 2 hours lab.

21-110 Problem Solving in Recreational Mathematics

Spring: 9 units

The emphasis is on learning to solve problems in elementary mathematics. Topics may vary among offerings of the course, but typically include puzzles, algebraic problems, number theory, and graph theory. 3 hrs. lec.

21-111 Calculus I

All Semesters: 10 units

Review of basic algebra, functions, limits, derivatives of algebraic, exponential and logarithmic functions, curve sketching, applications with emphasis on economic models. Successful completion of 21-111 and 21-112 entitles a student to enroll in any mathematics course for which 21-120 is a prerequisite. 3 hrs. lec., 2 hrs. rec.

21-112 Calculus II

All Semesters: 10 units

Indefinite integral, definite integral and applications, techniques of integration, trigonometric functions, functions of several variables, partial derivatives, maximum-minimum problems, Lagrange multipliers, geometric series, Newton's method, applications. Successful completion of 21-111 and 21-112 entitles a student to enroll in any mathematics course for which 21-120 is a prerequisite. 3 hrs. lec., 2 hrs. rec.

Prerequisites: 21111

21-115 Differential Calculus

Summer: Mini Session - 5 units

Functions, limits, derivatives, curve sketching, Mean Value Theorem, trigonometric functions, related rates, linear and quadratic approximations, maximum-minimum problems. 3 hrs. lec., 2 hrs. rec.

21-120 Differential and Integral Calculus

All Semesters: 10 units

Functions, limits, derivatives, logarithmic, exponential, and trigonometric functions, inverse functions; L'Hospital's Rule, curve sketching, Mean Value Theorem, related rates, linear and quadratic approximations, maximum-minimum problems, inverse functions, definite and indefinite integrals, and hyperbolic functions; applications of integration, integration by substitution and by parts. 3 hrs lec., 2 hrs. rec.

21-121 Integration and Differential Equations

Fall and Spring: 10 units

Differentiation review, L'Hospital's Rule, Mean Value Theorem, maximum-minimum problems. Definite and indefinite integrals; hyperbolic functions; applications of integration, integration by substitution and by parts. Integration by trigonometric substitution and partial fractions; arclength; improper integrals; Simpson's and Trapezoidal Rules for numerical integration; separable differential equations; first order linear differential equations, homogeneous second order linear differential equations with constant coefficients. 3 hrs. lec., 2 hrs. rec.

Prerequisites: 21115

21-122 Integration, Differential Equations and Approximation

All Semesters: 10 units

Integration by trigonometric substitution and partial fractions; arclength; improper integrals; Simpson's and Trapezoidal Rules for numerical integration; separable differential equations, first order linear differential equations, homogeneous second order linear differential equations with constant coefficients, series solution, Newton's method, Taylor's Theorem including a discussion of the remainder, sequences, series, power series. 3 hrs lec., 2 hrs. rec.

Prerequisites: 21112 or 21120 or 21121

21-123 Calculus of Approximation

Fall and Spring: Mini Session - 5 units

Newton's method, Taylor's Theorem including a discussion of the remainder, sequences, series, power series. 3 hrs. lec., 2 hrs. rec.

Prerequisites: 21121

21-125 Maple Lab

Intermittent: 3 units

An introduction to the symbolic programming package Maple using mathematical topics chosen from calculus and matrix algebra. Recommended to accompany any calculus course beyond 21-120 Differential and Integral Calculus. 1 hr. lec.

21-126 Introduction to Mathematical Software

Fall and Spring: 3 units

This course provides an introduction to the use of several software packages, which are useful to mathematics students. Among the packages are Maple and Mathematica for symbolic computing, TeX and LaTeX for mathematical documents, and Matlab for numerical computing. The course will also introduce the mathematical facilities built into spreadsheets such as Excel. The aim of the course is to provide the student with some basic skills in the use of this software without attempting complete coverage. A deeper knowledge of the software will be easy to obtain after completing this course. There are no prerequisites for the course, other than basic computer literacy and a knowledge of elementary mathematics. It is suggested that the course should be taken during the first two years of undergraduate studies.

21-127 Concepts of Mathematics

All Semesters: 9 units

This course introduces the basic concepts, ideas and tools involved in doing mathematics. As such, its main focus is on presenting informal logic, and the methods of mathematical proof. These subjects are closely related to the application of mathematics in many areas, particularly computer science. Topics discussed include a basic introduction to elementary number theory, induction, the algebra of sets, relations, equivalence relations, congruences, partitions, and functions, including injections, surjections, and bijections. A prerequisite for 15-211. 3 hrs. lec., 2 hrs. rec.

21-131 Analysis I

Fall: 10 units

An enriched first course in calculus, which includes a greater concentration on the foundations of the subject. Recommended for students with some prior background in calculus and who seek a deeper calculus course. Functions, limits, continuity; the Intermediate Value Theorem; the Riemann integral; the Fundamental Theorem of Calculus; integrability of continuous functions; the derivative and its significance; product rule, quotient rule, chain rule; Mean Value Theorem; inverse functions. 3 hrs. lec., 2 hrs. rec.

21-132 Analysis II

Spring: 10 units

A continuation of Analysis I. L'Hospital's rule; trigonometric, logarithmic, and exponential functions; techniques of integration; approximation by polynomials, Taylor's theorem; sequences, series, power series; introduction to linear differential equations. 3 hrs. lec., 2 hrs. rec.

Prerequisites: 21131

21-201 Undergrad Colloquium

Fall and Spring: 1 units

All mathematics majors meet for one hour each week to hear discussions on current research by faculty or students, presentations on mathematics from mathematicians outside academia, and expository talks on selected mathematical topics not part of the usual curricula. Also will include topics of special interest to undergraduates such as preparation for graduate school.

21-228 Discrete Mathematics

All Semesters: 9 units

The techniques of discrete mathematics arise in every application of mathematics, which is not purely continuous, for example in computer science, economics, and general problems of optimization. This course introduces two of the fundamental areas of discrete mathematics: enumeration and graph theory. The introduction to enumeration includes permutations, combinations, and topics such as discrete probability, combinatorial distributions, recurrence relations, generating functions, Ramsey's Theorem, and the principle of inclusion and exclusion. The introduction to graph theory includes topics such as paths, walks, connectivity, Eulerian and Hamilton cycles, planar graphs, Euler's Theorem, graph coloring, matchings, networks, and trees. 3 hrs. lec, 1 hr. rec.

Prerequisites: 21127

21-229 Set Theory

Spring: 9 units

Set theory was invented about 110 years ago by George Cantor as an instrument to understand infinite objects and to compare different sizes of infinite sets. Since then set theory has come to play an important role in several branches of modern mathematics, and serves as a foundation of mathematics. Contents: Basic properties of natural numbers, countable and uncountable sets, construction of the real numbers, some basic facts about the topology of the real line, cardinal numbers and cardinal arithmetic, the continuum hypothesis, well ordered sets, ordinal numbers and transfinite induction, the axiom of choice, Zorn's lemma. Optional topics if time permits: Infinitary combinatorics, filters and large cardinals, Borel and analytic sets of reals. 3 hrs. lec.

Prerequisites: 21127

21-235 Mathematical Studies I

Fall: 20 units

A unified and intensive presentation of algebra, analysis, and geometry by a team of instructors. For capable and dedicated students who can allot a substantial amount of time to the study of mathematics. Aims at providing a modern background in mathematics for a career in pure or applied mathematics, science, or engineering. Topics covered include analysis in IR, analysis in Euclidean spaces, linear algebra, geometry, algebraic theories, multi-linear algebra, ordinary differential equations. Covers and extends the material in the courses Calculus in Three Dimensions, Advanced Calculus I and II, Algebraic Structures, and Linear Algebra I. Normally taken by students in the third semester. Participation by invitation. Interested Freshmen should contact the Department in March.

Prerequisites: 21132

21-236 Mathematical Studies II

Spring: 20 units

A unified and intensive presentation of algebra, analysis, and geometry by a team of instructors. For capable and dedicated students who can allot a substantial amount of time to the study of mathematics. Aims at providing a modern background in mathematics for a career in pure or applied mathematics, science, or engineering. Topics covered include analysis in IR, analysis in Euclidean spaces, linear algebra, geometry, algebraic theories, multi-linear algebra, ordinary differential equations. Covers and extends the material in the courses Calculus in Three Dimensions, Advanced Calculus I and II, Algebraic Structures, and Linear Algebra I. Normally taken by students in the fourth semester. On completion a number of options are open, among them the Honors Degree Program. Participation by invitation.

Prerequisites: 21235

21-241 Matrix Algebra

Fall and Spring: 9 units

Vectors and matrices, the solution of linear systems of equations, vector spaces and subspaces, orthogonality, determinants, real and complex eigenvalues and eigenvectors, linear transformations. 3 hrs. lec.

21-256 Multivariate Analysis and Approximation

All Semesters: 9 units

Taylor's Theorem; geometric sequences and series and their applications in compound interest; vectors and matrices, lines, and planes; partial derivatives, directional derivatives, gradient, chain rule, maximum-minimum problems, Lagrange multipliers and the Kuhn-Tucker Theorem. 3 hrs. lec., 2 hrs. rec.

Prerequisites: 21112 or 21120 or 21121

21-257 Models and Methods for Optimization

All Semesters: 9 units

Introduces basic methods of operations research and is intended primarily for Business Administration and Economics majors. Review of linear systems; linear programming, including the simplex algorithm, duality, and sensitivity analysis; the transportation problem; the critical path method; the knapsack problem, traveling salesman problem, and an introduction to set covering models. 3 hrs. lec., 1 hr. rec.

Prerequisites: 06262 or 18202 or 21241 or 21256 or 21341

21-259 Calculus in Three Dimensions

All Semesters: 9 units

Vectors, lines, planes, quadratic surfaces, polar, cylindrical and spherical coordinates, partial derivatives, directional derivatives, gradient, divergence, curl, chain rule, maximum-minimum problems, multiple integrals, parametric surfaces and curves, line integrals, surface integrals, Green-Gauss theorems. 3 hrs. lec., 2 hrs. rec.

Prerequisites: 21112 or 21120 or 21121

21-260 Differential Equations

All Semesters: 9 units

Ordinary differential equations: first and second order equations, applications, Laplace transforms; partial differential equations: partial derivatives, separation of variables, Fourier series; systems of ordinary differential equations; applications. 3 hrs. lec., 1 hr. rec.

Prerequisites: 21122 or 21123 or 21132

21-270 Introduction to Mathematical Finance

Spring: 9 units

This is a first course for those considering majoring or minoring in Computational Finance. The theme of this course is pricing derivative securities by replication. The simplest case of this idea, static hedging, is used to discuss net present value of a non-random cash flow, internal rate of return, and put-call option parity. Pricing by replication is then considered in a one-period random model. Risk-neutral probability measures, the Fundamental Theorems of Asset Pricing, and an introduction to expected utility maximization and mean-variance analysis are presented in this model. Finally, replication is studied in a multi-period binomial model. Within this model, the replicating strategies for European and American options are determined. 3 hours lecture.

21-292 Operations Research I

Spring: 9 units

Operations research offers a scientific approach to decision making, most commonly involving the allocation of scarce resources. This course develops some of the fundamental methods used. Linear programming: the simplex method and its linear algebra foundations, duality, post-optimality and sensitivity analysis; the transportation problem; the critical path method; non-linear programming methods. 3 hrs. lec., 1 hr. rec.

Prerequisites: (21122 or 21132) and (21241 or 21341)

21-295 Putnam Seminar

Fall: 3 units

A problem solving seminar designed to prepare students to participate in the annual William Lowell Putnam Mathematical Competition. Students solve and present their solutions to problems posed. 1.5 hrs. lecture/lab.

21-300 Basic Logic

Fall: 9 units

Propositional and predicate logic: Syntax, proof theory and semantics up to completeness theorem, Lowenheim Skolem theorems, and applications of the compactness theorem. 3 hrs. lec.

Prerequisites: 21127 and (21132 or 21228 or 21373 or 21484)

21-301 Combinatorics

Fall: 9 units

A major part of the course concentrates on algebraic methods, which are relevant in the study of error correcting codes, and other areas. Topics covered in depth include permutations and combinations, generating functions, recurrence relations, the principle of inclusion and exclusion, and the Fibonacci sequence and the harmonic series. Additional topics may include existence proofs, partitions, finite calculus, generating combinatorial objects, Polya theory, codes, probabilistic methods. 3 hrs. lec

Prerequisites: 21122 and 21127

21-320 Symbolic Programming Methods

Intermittent: 9 units

The objective of this course is to learn to program in Maple, a powerful symbolic mathematics package available on many platforms at Carnegie Mellon. After learning what Maple can do with the commands provided with the package, students will learn to develop their own Maple functions to accomplish extended mathematical computations. Grades in the course will be based mostly on project work. Projects may come from any relevant field and may be graphical, numerical, or symbolic or all three. The course will involve online demonstrations in most classes. 3 hrs. lec.

21-325 Probability

Fall: 9 units

This course focuses on the understanding of basic concepts in probability theory and illustrates how these concepts can be applied to develop and analyze a variety of models arising in computational biology, finance, engineering and computer science. The firm grounding in the fundamentals is aimed at providing students the flexibility to build and analyze models from diverse applications as well as preparing the interested student for advanced work in these areas. The course will cover core concepts such as probability spaces, random variables, random vectors, multivariate densities, distributions, expectations, sampling and simulation; independence, conditioning, conditional distributions and expectations; limit theorems such as the strong law of large numbers and the central limit theorem; as well as additional topics such as large deviations, random walks and Markov chains, as time permits. 3 hours lecture.

Prerequisites: 21122 and 21259

21-341 Linear Algebra

Fall and Spring: 9 units

Fields, vector spaces, subspaces, linear independence, basis and dimension, matrices and linear equations, linear transformations, groups, rank and nullity theorem, change of basis, inner product spaces, eigenvalues and eigenvectors. 3 hours lecture.

Prerequisites: 21127

21-342 Linear Algebra II

Intermittent: 9 units

General spectral theory, invariant subspaces, canonical forms, duality and multilinear algebra, bilinear forms, quotient spaces, direct sums, tensor products, normal transformations in inner product spaces. Applications of linear algebra: Possible topics include combinatorics, coding theory, cryptography, differential equations, finite symmetry groups. 3 hours lecture.

Prerequisites: 21341

21-350 History of Mathematics

Intermittent: 9 units

Mathematics has a long and interesting history, and there is much insight into both mathematics and history to be gained from its study. The emphasis here will be on learning the mathematics with the added value of appreciating it in historical context. Selected topics may range from early number systems, the development of geometry, the emergence of the ideas of analysis, through to the origins of modern set theory. 3 hrs. lec.

21-355 Principles of Real Analysis I

Fall and Spring: 9 units

The Real Number System: Field and order axioms, sups and infs, completeness, integers and rational numbers. Real Sequences: Limits, cluster points, limsup and liminf, subsequences, monotonic sequences, Cauchy's criterion, Bolzano-Weierstrass Theorem. Topology of the Real Line: Open sets, closed sets, density, compactness, Heine-Borel Theorem. Continuity: attainment of extrema, Intermediate Value Theorem, uniform continuity. Differentiation: Chain Rule, local extrema, Mean-Value Theorems, L'Hospital's Rule, Taylor's Theorem. Riemann Integration: Partitions, upper and lower integrals, sufficient conditions for integrability, Fundamental Theorem of Calculus. Sequences of Functions: Pointwise convergence, uniform convergence, interchanging the order of limits. 3 hours lecture. Prerequisites: 21122 and 21127

21-356 Principles of Real Analysis II

Spring: 9 units

Topology in metric spaces, specialization to finite dimensional normed linear spaces. Vector differential calculus: continuity and the total derivative, partial derivatives, directional derivatives, gradients, Jacobians, the chain rule, implicit function theorem. Vector integral calculus: double and triple integrals, arclength and surface area, line integrals, Green's Theorem, surface integrals, Divergence and Stokes Theorems. If time permits: trigonometric series, Fourier series for orthonormal bases, minimization of square error. 3 hours lecture.

Prerequisites: 21241 and 21259 and 21355

21-357 Sequences and Series of Functions

Fall: 9 units

This course serves as a sequel to Advanced Calculus I. The course begins with a thorough coverage of uniform and pointwise convergence of sequences and series of functions. This is followed by application to power series and Fourier series. Additional topics may include (at the discretion of the instructor and as time permits) the Weierstrass approximation theorem, metric spaces, contraction mapping, existence of solutions to ODEs, the Arzela-Ascoli theorem, and wavelets. 3 hrs. lec.

Prerequisites: 21241 and 21259 and 21355

21-365 Projects in Applied Mathematics

Fall: 9 units

This course provides students with an opportunity to solve problems posed by area companies. It is also designed to provide experience working as part of a team to solve problems for a client. The background needed might include linear programming, simulation, data analysis, scheduling, numerical techniques, etc.

21-366 Topics in Applied Mathematics

Intermittent: 9 units

Typical of courses that might be offered from time to time are game theory, non-linear optimization, and dynamic programming.

Prerequisites will vary with topic. 3 hrs. lec.

Prerequisites: 21420 or 36410

21-369 Numerical Methods

Fall and Spring: 9 units

This course provides an introduction to the use of computers to solve scientific problems. Methods for the computational solution of linear algebra systems, nonlinear equations, the interpolation and approximation of functions, differentiation and integration, and ordinary differential equations. Analysis of roundoff and discretization errors and programming techniques. 3 hrs. lec.

Prerequisites: 15100 and 21259

21-370 Discrete Time Finance

Fall: 9 units

This course introduces the Black-Scholes option pricing formula, shows how the binomial model provides a discretization of this formula, and uses this connection to fit the binomial model to data. It then sets the stage for Continuous-Time Finance by discussing in the binomial model the mathematical technology of filtrations, martingales, Markov processes and risk-neutral measures. Additional topics are American options, expected utility maximization, the Fundamental Theorems of Asset Pricing in a multi-period setting, and term structure modeling, including the Heath-Jarrow-Morton model. Students in 21-370 are expected to read and write proofs. 3 hours lecture.

Prerequisites: (21270 or 70492) and (21256 or 21259)

Corequisites: 21-325, 36-225, 36-217, 70-207

21-371 Functions of a Complex Variable

Intermittent: 9 units

This course provides an introduction to one of the basic topics of both pure and applied mathematics and is suitable for those with both practical and theoretical interests. Algebra and geometry of complex numbers; complex differentiation and integration. Cauchy's theorem and applications; conformal mapping; applications. 3 hrs. lec.

Prerequisites: 21259 and 21260

21-372 Partial Differential Equations

Spring: 9 units

This course provides an introduction to partial differential equations and is recommended for majors in mathematics, physical science, or engineering. Boundary value problems on an interval, Fourier series, uniform convergence, the heat, wave, and potential equations on bounded domains, general theory of eigenfunction expansion, the Fourier integral applied to problems on unbounded domains, introduction to numerical methods. 3 hrs. lec.

Prerequisites: 21259 and 21260

21-373 Algebraic Structures

Fall and Spring: 9 units

Groups: Homomorphisms. Subgroups, cosets, Lagrange's theorem. Conjugation. Normal subgroups, quotient groups, first isomorphism theorem. Group actions, Cauchy's Theorem. Dihedral and alternating groups. The second and third isomorphism theorems. Rings: Subrings, ideals, quotient rings, first isomorphism theorem. Polynomial rings. Prime and maximal ideals, prime and irreducible elements. PIDs and UFDs. Noetherian domains. Gauss' lemma. Eisenstein criterion. Fields: Field of fractions of an integral domain. Finite fields. Applications to coding theory, cryptography, number theory. 3 hours lecture.

Prerequisites: (21241 or 21341) and 21127

21-374 Field Theory

Spring: 9 units

The purpose of this course is to provide a successor to Algebraic Structures, with an emphasis on applications of groups and rings within algebra to some major classical problems. These include constructions with a ruler and compass, and the solvability or unsolvability of equations by radicals. It also offers an opportunity to see group theory and basic ring theory "in action", and introduces several powerful number theoretic techniques. The basic ideas and methods required to study finite fields will also be introduced. These ideas have recently been applied in a number of areas of theoretical computer science including primality testing and cryptography. 3 hrs. lec.

Prerequisites: 21373

21-380 Introduction to Mathematical Modeling

Intermittent: 9 units

This course shall examine mathematical models, which may be used to describe natural phenomena. Examples, which have been studied include: continuum description of highway traffic, discrete velocity models of a monotonic gas, chemotactic behavior in biological systems, European options pricing, and cellular-automata. Systems such as the first four are described by partial differential equations; the last involves discrete-time and discrete-phase dynamical systems, which have been used to successfully represent both physical and biological systems. The course will develop these models and then examine the behavior of the underlying systems, both analytically and numerically. The mathematical tools required will be developed in the course.

Prerequisites: 21241 and 21260

21-393 Operations Research II

Fall: 9 units

An important goal of this course is for the student to gain experience with the process of working in a group to solve a problem. Much of the course is devoted to a group project based upon case studies and methods presented. Topics may include combinatorial optimization, game theory, integer programming, heuristic methods. 3 hrs. lec.

Prerequisites: 21257 or 21292

21-420 Continuous-Time Finance

Spring: 9 units

This course begins with Brownian motion, stochastic integration, and Ito's formula from stochastic calculus. This theory is used to develop the Black-Scholes option pricing formula and the Black-Scholes partial differential equation. Additional topics may include models of credit risk, simulation, and expected utility maximization. 3 hours lecture.

Prerequisites: (21260 or 18202) and 21370 and (36225 or 21325 or 36217)

21-440 Selected Topics in Algebra

Intermittent: 9 units

Typical of courses which are offered from time to time are Boolean algebras, algebraic theory of semigroups, rings and ideals, number theory, inequalities.

21-441 Number Theory

Fall: 9 units

Number theory deals with the integers, the most basic structures of mathematics. It is one of the most ancient, beautiful, and well-studied branches of mathematics, and has recently found surprising new applications in communications and cryptography. Course contents: Structure of the integers, greatest common divisors, prime factorization. Modular arithmetic, Fermat's Theorem, Chinese Remainder Theorem. Number theoretic functions, e.g. Euler's function, Mobius functions, and identities. Diophantine equations, Pell's Equation, continued fractions. Modular polynomial equations, quadratic reciprocity. 3 hrs. lec.

Prerequisites: 21127 and 21241

21-450 Topics in Geometry

Intermittent: 9 units

Typical of courses, which are offered from time to time are convex sets, differential geometry, projective geometry, and classical geometry. 3 hrs. lec.

Prerequisites: 21356 or 21460

21-460 Topology

Intermittent: 9 units

This course introduces the topological concepts that underlie analysis. Included are metric spaces, topological spaces, separation, compactness, convergence, and connectedness. Also included are constructions and concepts in topological spaces that parallel those found elsewhere in mathematics such as quotients, products, sums, factorization of mappings, and isomorphisms. Other topics included as time permits according to the interests of the instructor. 3 hrs. lec.

Prerequisites: 21355

21-465 Topology and Geometry

Spring: 9 units

Review of metric spaces. Topological spaces. Separation axioms. Open, closed and compact sets. Continuous functions. Product spaces, subspaces, quotient spaces. Connectedness and path-connectedness. Homotopy. Fundamental group of a pointed space. Simply connected spaces. Winding number, the fundamental group of the circle. Functorial property of the fundamental group. Brouwer fixed point theorem. Covering spaces. van Kampen's theorem. 2-manifolds. Triangulations. Euler characteristic. Surgery, classification of 2-manifolds. Riemannian manifolds, length, angle and curvature. Geodesics. The upper half plane, action of $SL_2(\mathbb{Z})$, fundamental region. 3 hours lecture.

Prerequisites: 21356 and 21373

21-470 Selected Topics in Analysis

Intermittent: 9 units

Typical of courses, which are offered from time to time are finite difference equations, calculus of variations, and applied control theory. 3 hrs. lec.

Prerequisites: (21236) or (21241 and 21355)

21-476 Ordinary Differential Equations

Intermittent: 9 units

Review of solution techniques, modeling techniques, existence and uniqueness, numerical procedures, linear equations and systems, special functions, autonomous non-linear systems, qualitative techniques. 3 hrs. lec.

Prerequisites: 21241 and 21260

21-484 Graph Theory

Spring: 9 units

Graph theory uses basic concepts to approach a diversity of problems and nontrivial applications in operations research, computer science and other disciplines. It is one of the very few mathematical areas where one is always close to interesting unsolved problems. Topics include graphs and subgraphs, trees, connectivity, Euler tours and Hamilton cycles, matchings, graph colorings, planar graphs and Euler's Formula, directed graphs, network flows, counting arguments, and graph algorithms. 3 hrs. lec.

Prerequisites: 21127

21-590 Practicum

All Semesters: 3-12 units

Students in this course gain experience with the application of mathematical models to business and/or industrial problems during an internship. The internship is set up by the student in consultation with a faculty member. The students must also have a mentor at the firm providing the internship, who together with the faculty member develops a description of the goals of the internship. The internship must include the opportunity to learn about problems which have mathematical content.

21-599 Undergraduate Reading and Research

Fall and Spring: 0-99 units

Individual reading courses or projects in mathematics and its applications. Prerequisites and units to be negotiated with individual instructors.

21-600 Mathematical Logic I

Fall: 12 units

The study of formal logical systems, which model the reasoning of mathematics, scientific disciplines, and everyday discourse. Propositional Calculus and First-order Logic. Syntax, axiomatic treatment, derived rules of inference, proof techniques, computer-assisted formal proofs, normal forms, consistency, independence,

semantics, soundness, completeness, Lowenheim-Skolem Theorem, compactness, equality. 3 hrs. lec.
Prerequisites: 21132 or 21228 or 21373 or 21484

21-602 Introduction to Set Theory I

Fall: 12 units

First order definability and the Zermelo-Fraenkel axioms; cardinal arithmetic, ordered sets, well-ordered sets (axiom of choice), transfinite induction, the filter of closed unbounded sets (Fodor, Ulm and Solovay's theorems), Delta systems, basic results in partition calculus (e.g., Ramsey's Theorem and the Erdos-Rado Theorem); small to medium large cardinals; applications to general topology (e.g., Alexandroff's conjecture), and the basic ideas of descriptive set theory. The independence of Suslin conjecture from the usual axioms. Godel's axiom of constructibility. Time permitting, the Galvin-Hajnal-Shelah inequality will be proved. 3 hrs. lec.

21-603 Model Theory I

Intermittent: 12 units

Similarity types, structures; downward Lowenheim Skolem theorem; construction of models from constants, Henkin's omitting types theory, prime models; elementary chains of models, basic two cardinal theorems, saturated models, basic results on countable models including Ryll-Nardzewski's theorem; indiscernible sequences, Ehrenfeucht-Mostowski models; introduction to stability, rank functions, primary models, and a proof of Morley's categoricity theorem; basic facts about infinitary languages, computation of Hanf-Morley numbers.

21-610 Algebra I

Spring: 12 units

The structure of finitely generated abelian groups, the Sylow theorems, nilpotent and solvable groups, simplicity of alternating and projective special linear groups, free groups, the Nielsen-Schreier theorem. Vector spaces over division rings, field extensions, the fundamental Galois correspondence, algebraic closure. The Jacobson radical and the structure of semisimple rings. Time permitting, one of the following topics will be included: Wedderburn's theorem on finite division rings, Frobenius' Theorem. Prerequisite: Familiarity with the content of an undergraduate course on groups and rings. 3 hrs. lec.

21-620 Real Analysis

Fall: Mini Session - 6 units

A review of one-dimensional, undergraduate analysis, including a rigorous treatment of the following topics in the context of real numbers: sequences, compactness, continuity, differentiation, Riemann integration. (Mini-course. Normally combined with 21-621.) 3 hrs. lec.

21-621 Introduction to Lebesgue Integration

Fall: Mini Session - 6 units

Construction of Lebesgue measure and the Lebesgue integral on the real line. Fatou's Lemma, the monotone convergence theorem, the dominated convergence theorem. (Mini-course. Normally combined with 21-620.) 3 hrs. lec.

21-651 General Topology

Fall: 12 units

Metric spaces: continuity, compactness, Arzela-Ascoli Theorem, completeness and completion, Baire Category Theorem. General topological spaces: bases and subbases, products, quotients, subspaces, continuity, topologies generated by sets of functions, homeomorphisms. Convergence: nets, filters, and the inadequacy of sequences. Separation: Hausdorff spaces, regular spaces, completely regular spaces, normal spaces, Urysohn's Lemma, Tietze's Extension Theorem. Connectedness. Countability conditions: first and second countability, separability, Lindelof property. Compactness: Tychonoff's Theorem, local compactness, one-point compactification. 3 hrs. lec.

21-660 Introduction to Numerical Analysis I

Spring: 12 units

Finite precision arithmetic, interpolation, spline approximation, numerical integration, numerical solution of linear and nonlinear systems of equations, optimization in finite dimensional spaces. 3 hrs. lec.

21-700 Mathematical Logic II

Spring: 12 units

Higher-order logic (type theory). Syntax, Lambda-notation, Axioms of Description and Choice, computer-assisted formal proofs, semantics, soundness, standard and non-standard models, completeness, compactness, formalization of mathematics,

definability of natural numbers, representability of recursive functions, Church's Thesis. Godel's Incompleteness Theorems, undecidability, undefinability.
Prerequisites: 21300 or 21600

Mechanical Engineering

24-101 Fundamentals of Mechanical Engineering

Fall and Spring: 12 units

The purpose of this course is to introduce the student to the field of mechanical engineering through an exposition of its disciplines, including structural analysis, mechanism design, fluid flows, and thermal systems. By using principles and methods of analysis developed in lectures, students will complete two major projects. These projects will begin with conceptualization, proceed with the analysis of candidate designs, and culminate in the construction and testing of a prototype. The creative process will be encouraged throughout. The course is intended primarily for CIT freshmen. 3 hrs. lec., 2 hrs. rec./lab.

Corequisites: 21-115, 21-116, 33-106

24-201 Engineering Graphics

Fall and Spring: 9 units

Introduction to the use and preparation of manually and computer generated engineering drawings, including the following topics: basic drawing techniques; dimensioning of orthographic drawings; auxiliary and oblique views; sectional drawings; working drawings; blueprint reading; freehand sketching; production standards, methods, and symbols; simplified drawing techniques; intersection and development; basic applied descriptive geometry. 3 hrs. rec., 3 hrs. lab.

24-221 Thermodynamics I

Fall: 10 units

Temperature and thermometry; equations of state for fluids and solids; work, heat, and the first law; internal energy, enthalpy, and specific heats; energy equations for flow; change of phase; the second law, reversibility, absolute temperature, and entropy; combined first and second laws; availability; power and refrigeration cycles. Applications to a wide range of processes and devices. 3 hrs. lec.

Prerequisites: 24101 AND 33106 AND (21122 or 21123)

24-231 Fluid Mechanics

Spring: 10 units

Hydrostatics. Control volume concepts of mass, momentum, and energy conservation. Euler's and Bernoulli's equations. Viscous flow equations. Head loss in ducts and piping systems. Dimensional analysis and similitude as an engineering tool. Measurement techniques. 3 hrs. lec., 1 hr. rec.

Prerequisites: 33106 AND (21122 or 21123)

24-261 Statics

Fall: 10 units

This course is the first in a two-semester sequence on the solid mechanics of engineering structures and machines. The course begins with a review of the statics of rigid bodies, which includes the identification of statically indeterminate problems. Two- and three-dimensional statics problems are treated. Thereafter, the course studies stresses and deflections in deformable components. In turn, the topics covered are: simple tension, compression, and shear; thin-walled pressure vessels; torsion; and bending of beams. For each topic, statically indeterminate problems are analyzed and elementary considerations of strength are introduced. 3 hrs. lec., 1 hr. rec./lab.

Prerequisites: (21118 or 21122 or 21123) AND 33106

24-262 Stress Analysis

Spring: 12 units

This course is the second in a two-semester sequence on the solid mechanics of engineering structures and machines. The basic topics of uniaxial tension/compression, torsion, and flexural deformation from 24-261 are reviewed. Combined loadings and stresses are then treated, which lead to a consideration of failure criteria. Two-dimensional elasticity and the finite element method are introduced. Stress concentrations are quantified analytically, numerically, and with the use of engineering handbooks. Cyclic failure criteria are introduced, and both static and cyclic failure criteria are applied to results from numerical analysis. 3 hrs. lec., 1 hr. rec./lab.

Prerequisites: 24261 and 33106

24-302 Mechanical Engineering Seminar I

Fall and Spring: 2 units

The purpose of this course is to help students develop good presentation skills and to provide a forum for presentations and discussions of professional ethics. Students will make at least two presentations, one of which is related to professional ethics. Student grades will be based on their presentation skills and their participation in class discussions. 1 hr. rec.

Prerequisites: Junior standing or permission of instructor

24-311 Numerical Methods

Fall: 12 units

Use of numerical methods for solving engineering problems with the aid of a digital computer. The course will contain numerical methods such as roots of equations, linear algebraic equations, optimization, curve fitting, and integral and differential equation solving. MATLAB will be used as the programming language. Programming cluster laboratory times will be available twice a week. Problems will be drawn from all fields of interest to mechanical engineers. 3 hrs. lecture plus lab

Prerequisites: 21260

24-321 Thermal-Fluids Experimentation and Design

Spring: 12 units

24-321 Thermal-Fluids Experimentation and Design Spring: 12 units This is a capstone course for the thermal-fluids core-course sequence. This course is comprised of two elements: experimentation and design. The experimental experience covers techniques of measurement, uncertainty analysis, and realization of systems, which demonstrate fundamental principles in thermodynamics, fluid mechanics, and heat transfer. The practice of designing a thermal system is also integrated into this course. 4 hrs. lec./lab Pre-requisites: 24-221 (Thermodynamics I), 24-231 (Fluid Mechanics), 24-322 (Heat Transfer)

Prerequisites: 24221 and 24231 and 24322

24-322 Heat Transfer

Fall: 10 units

Introduction to basic concepts of engineering heat transfer. Steady and transient heat conduction in solids, including the effect of heat generation. Finned surfaces. Correlation formulas for forced and free convection, condensation, and boiling. Design and analysis of heat exchangers. Radiation heat transfer. Problems in combined convection and radiation. Measurement techniques. 3 hrs. lec., 1 hr. recitation.

Prerequisites: 21260 and 24221 and 24231

24-331 Viscous Flow

Intermittent: 10 units

The concept of fluid shear and viscosity and viscous flow in tubes and channels. Hydrodynamic lubrication of bearings. The concept of turbulence and turbulent flow in tubes and channels. The boundary layer concept and applications to momentum transfer (drag), energy transfer (heat convection), and mass transfer (evaporation, etc.). 3 hrs. rec., 1 hr. lab

Prerequisites: 21259 and 21260 and 24221 and 24231

24-332 Potential Flow Aerodynamics

Intermittent: 9 units

Development of the fundamental equations of incompressible frictionless flow. Concepts of circulation, vorticity, irrotationality, stream function, and velocity potential. Two-dimensional low speed airfoil theory; lift and moment calculations for the infinite span wing; empirical airfoil data for real airfoils; thin airfoil theory. Three-dimensional effects; flow distribution; Prandtl's wing theory; induced drag; the elliptical lift distribution; the general lift distribution. 3 hrs. rec.

Prerequisites: 21259 and 21260 and 24231

24-333 Gas Dynamics

Intermittent: 9 units

Development of the foundations of frictionless compressible flow. Internal flow with friction and heat transfer. Acoustics and wave motion. Oblique shocks and expansion waves. Two-dimensional subsonic and supersonic flow including hodograph transformations, linearized theory of thin airfoils, and the method of characteristics. Introduction to transonic and hypersonic flow and reentry problems. 3 hrs. rec.

Prerequisites: 21259 and 21260

24-341 Manufacturing Sciences

Spring: 9 units

This course has two broad concerns: an introductory review of manufacturing systems organization and a review of common manufacturing processes from the point of view of design for

manufacturability. The features of mass and batch production are quantitatively considered. The basic principles of group technology and production planning are outlined. The use of computers in manufacturing is described, together with a review of the current capabilities of industrial robots. Students will be involved in weekly seminars, which will describe the basic features of common manufacturing processes, including metal machining, metal forming, polymer processing, casting techniques, joining techniques, ceramic processing, and powder processing. Case studies from industry and films may be used. 3 hrs. rec.

Prerequisites: 24262

24-351 Dynamics

Fall: 10 units

This first course on the modeling and analysis of dynamic systems concentrates on the motion of particles, systems of particles, and rigid bodies under the action of forces and moments. Topics include the kinematics of motion in rectangular, polar, and intrinsic coordinates; relative motion analysis with multiple reference frames; and planar kinetics through the second law, work-energy method, and impulse-momentum method. Time and frequency domain solutions to first and second order equations of motion are discussed. 3 hrs. lec. 1 hr rec.

Prerequisites: 24261

24-352 Dynamic Systems and Controls

Spring: 12 units

This second course on the modeling and analysis of dynamic systems emphasizes the common features, which are exhibited by physical systems that include mechanical, hydraulic, pneumatic, thermal, electrical, and electromechanical elements. State equations and the concepts of equilibrium, linearization, and stability are discussed. Time and frequency domain solutions are developed. 4 hr. lec.

Prerequisites: 21260 and 24351 and 33107

24-353 Intermediate Dynamics

Intermittent: 9 units

This course presents classical (i.e., nonrelativistic) dynamics via the vector formulation of Newtonian mechanics and the analytical dynamics of Lagrange's equations. Classical dynamics is used for the purpose of obtaining mathematical models of dynamic systems which are then employed in the analysis of dynamic behavior and in design synthesis. Course contents include a review of particle kinematics and Newton's laws, kinematics of rigid bodies in general motion, Newtonian kinetics of rigid bodies including the Newton-Euler equations of motion, impulse-momentum and work-energy methods, fundamentals of analytical mechanics including the principle of virtual work and Hamilton's principle leading to Lagrange's equations of motion, and advanced issues of analytical mechanics. 3 hrs. lec.

24-355 Kinematics and Dynamics of Mechanisms

Intermittent: 9 units

This design-oriented course addresses the kinematics and dynamics of mechanisms with applications to linkage systems, reciprocating engines, and industrial machinery. Conventional as well as innovative rigid-body dynamic systems are studied. Problems of kinematics and dynamics are framed in a form suited for computer analysis. The course bridges analysis and design by emphasizing the synthesis of mechanisms. To stimulate a creative approach, homework and project work draw upon actual engineering design problems. 3 hrs. rec.

Prerequisites: 24351

24-356 Engineering Vibrations

Intermittent: 11 units

Frequency response of linear mechanical systems, with and without damping. Use of computational methods for simulating system response and the use of modal analysis for understanding the vibratory response of complex systems. Lumped and distributed mass systems. Applications include isolation, stability, and balancing. 3 hrs. lec., 1 hr. rec.

Prerequisites: 21260

24-361 Intermediate Stress Analysis

Intermittent: 10 units

This course first reviews important solutions from strength of materials, Mohr's circle, and multiaxial failure theories. Students are then introduced to the theory of elasticity with an emphasis on understanding the field equations and boundary conditions. A short introduction to the theory of finite element methods is given. Additional topics covered include buckling, stress concentrations, plasticity, and fracture mechanics. An important aspect of the course is teaching students how topics covered in class can be applied to predict or understand failures in engineering applications. Another

important skill that is emphasized is the application of fundamentals from the lectures and physical intuition to interpret results generated by finite element models. 3 hrs. lec., 1 hr. lab.
Prerequisites: 21259 and 24262

24-370 Engineering Design I: Methods and Skills
Spring: 12 units

24-370 Engineering Design I: Methods and Skills Spring: 12 Units In this course, students will learn methods and skills for the engineering design process, consisting of four stages: concept design, detail design, analysis, and manufacturing. The course covers the engineering design process in a holistic fashion by discussing theories and practices of the four stages and inter-relating them. Some hands-on assignments, including computational assignments, are given to enhance the learning outcome. After taking this course, students will be able to: express ideas in sketches; interpret and create engineering drawings; select and apply machine elements; model detailed shapes with CAD tools; analyze product performance with CAE tools; and choose materials and manufacturing schemes. Co-requisites: 24-262 (stress analysis) and junior status
Prerequisites: Corequisites: 24-262

24-380 Special Topics in Mechanical Engineering
Intermittent: 9 units

The Special Topics in Mechanical Engineering courses provide students with exposure to a variety of advanced concepts related to Mechanical Engineering and are offered on an "as available" basis. The final digit reflects the primary application area of the material, where 0 is professional; 1 is mathematics; 2 is thermal engineering; 3 is fluid mechanics; 4 is design and manufacturing; 5 is dynamics and controls; and 6 is solid mechanics.

24-391 Mechanical Engineering Project

All Semesters: 3-12,18 units
Practice in the organization, planning, and execution of appropriate engineering projects. These investigations may be assigned on an individual or a team basis and in most cases will involve experimental work. 9 hrs. lab.

24-392 Mechanical Engineering Project

All Semesters: 3-18 units
Practice in the organization, planning, and execution of appropriate engineering projects. These investigations may be assigned on an individual or a team basis and in most cases will involve experimental work. 9 hrs. lab.

24-415 Microfluidics
Intermittent: 9 units

This course offers an introduction to the emerging field of microfluidics with an emphasis on chemical and life sciences applications. During this course students will examine the fluid dynamical phenomena underlying key components of "lab on a chip" devices. Students will have the opportunity to learn practical aspects of microfluidic device operation through hands-on laboratory experience, computer simulations of microscale flows, and reviews of recent literature in the field. Throughout the course, students will consider ways of optimizing device performance based on knowledge of the fundamental fluid mechanics. Students will explore selected topics in more detail through a semester project. Major course topics include pressure-driven and electrokinetically-driven flows in microchannels, surface effects, micro-fabrication methods, micro/nanoparticles for biotechnology, biochemical reactions and assays, mixing and separation, two-phase flows, and integration and design of microfluidic chips. 3 hrs lec.
Prerequisites: 24-231 or 06-261 or 12-355 Cross-listed with 24-715

24-421 Internal Combustion Engines
Fall: 10 units

Basic principles and fundamentals of internal combustion engines; gas turbine, spark ignition and diesel compression ignition engines. Combustion chamber design. Monitoring and control of fuel efficiency and emission of pollutants in exhaust gases. Developments in direct injection, rotary, prechamber and stratified charge engines. Ignition, fuel injection, mixing and combustion processes, heat release, and energy balances. Engine laboratory projects include: air and fuel controls, measurement of particulate and species concentrations in exhaust gases. 3 hrs. rec., 1 hr. lab.
Prerequisites: 24221 and 24231 Corequisites: 24-322

24-422 Thermal System Analysis
Intermittent: 9 units

Performance studies of various thermal processes and devices with emphasis on energy utilization and environmental impact. Examples may be drawn from nuclear power plant processes, jet propulsion,

energy conversion, internal and external combustion engines, desalination, and other areas of current interest. 3 hrs. rec.
Prerequisites: 24221 and 24321

24-423 Direct Energy Conversion
Intermittent: 9 units

Principles of energy conversion between various forms of energy including heat, electricity, and light. Applications. Theory of thermoelectric, thermionic, magnetohydrodynamic, and photovoltaic direct conversion devices. Principles of chemical and mechanical energy storage.

24-424 Energy and the Environment
Intermittent: 9 units

Fuel cycles for conventional and non-conventional energy resources; relationships between environmental impacts and the conversion or utilization of energy; measures of system and process efficiency; detailed study and analysis of coal-based energy systems including conventional and advanced power generation, synthetic fuels production, and industrial processes; technological options for multi-media (air, water, land) pollution control; mathematical modeling of energy-environmental interactions and tradeoffs and their dependency on technical and policy parameters; methodologies for energy and environmental forecasting; applications to issues of current interest.

24-425 Combustion and Air Pollution Control
Intermittent: 9 units

Formation and control of gaseous and particulate air pollutants in combustion systems. Basic principles of combustion, including thermochemical equilibrium, flame temperature, chemical kinetics, hydrocarbon chemistry, and flame structure. Formation of gaseous and particulate pollutants in combustion systems. Combustion modifications and post-combustion technologies for pollutant control. Relationship between technology and regional, national, and global air pollution control strategies. The internal combustion engine and coal-fired utility boiler are used as examples.

24-441 Engineering Design II: Conceptualization and Realization
Fall and Spring: 12 units

This course guides students through the design process in the applied design of a practical mechanical system. Lectures describe the typical design process and its associated activities, emphasizing methods for innovation and tools for design analysis. Professional and ethical responsibilities of designers, interactions with clients and other professionals, regulatory aspects, and public responsibility are discussed. The design project is typically completed in teams and is based on a level of engineering knowledge expected of seniors. Proof of practicality is required in the form of descriptive documentation. Frequently, a working model will also be required. Oral progress reports and a final written and oral report are required. 3 hrs. rec., 3 hrs lab
Prerequisites: 24262 Corequisites: 24-370

24-443 Design for Manufacture
Fall: 9 units

Introduces methods for concurrent design and manufacturing. Course topics will include methods of value engineering, function logic, design review process, Taguchi analysis, design of experiments, design for assembly, process selection, statistical process control, and discussion of such topics as net shape processes, zero quality control, just-in-time, FMS and robotics. Emphasis on analytical methods and their application to the design of products and manufacturing processes. Project oriented. 3 hrs. lec.

24-451 Feedback Control Systems
Fall: 12 units

Fundamentals of feedback control with emphasis on classical techniques and an introduction to state space methods. Topics include the following: frequency domain modeling and state space modeling of dynamical systems; feedback control system concepts and components; control system performance specifications such as stability, transient response, and steady state error; analytical and graphical methods for analysis and design - root locus, Bode plot, Nyquist criterion; design and implementation of proportional, proportional-derivative, proportional-integral-derivative, lead, lag, and lead-lag controllers. Laboratory work will include implementation and evaluation of various controllers on real systems for comparison with analytical models. Extensive use of computer aided analysis and design software. 3 hrs. lec., 3 hrs. lab.
Prerequisites: (15100 or 15111) AND 24352

24-452 Mechanical Systems Experimentation

Fall: 9 units

Experimentation in dynamic systems and controls. The course will cover translational and rotational systems. Topics will include mechanical elements, natural frequencies, mode shapes, free and forced response, frequency response and Bode plots, time constants, transient response specifications, feedback controls such as PID control, and stability for single-degree-of-freedom and multi-degree-freedom systems. The course will introduce and use state-of-the-art experimentation hardware and software. 1 hr. lecture, 2 hrs. lab.

Prerequisites: Corequisites: 24-352

24-484 Decision Tools for Engineering Design and Entrepreneurship

Intermittent: 12 units

This course provides engineers with a multidisciplinary mathematical foundation for integrated modeling of engineering design and enterprise planning decisions in an uncertain, competitive market. Topics include economics in product design, manufacturing and operations modeling and accounting, consumer choice modeling, survey design, conjoint analysis, decision-tree analysis, optimization, game theory, model integration, and professional communication skills. Students will apply theory and methods to a team project for a new product or emerging technology of their choice, developing a business plan to defend technical and economic competitiveness. Students may choose to select emerging technologies from research at Carnegie Mellon for study in the course, and in some years venture capitalists and other industry leaders will take part in critiquing student projects. This course assumes some prior programming experience in Matlab.

Prerequisites: 21259

24-491 Department Research Honors

Fall and Spring: 3-24 units

This course is designed to give students increased exposure to "open-ended" problems and research type projects. It involves doing a project on a research or design topic and writing a thesis describing that project. The project would be conducted under the supervision of a mechanical engineering faculty member (the advisor), and must be approved by the advisor before inception. This course can be taken at any time after the Junior year and before graduation which includes the summer after the Junior year. Completion of 18 units of this course with a grade of B or better is a partial fulfillment of the requirements for Departmental Research Honors.

24-492 Department Research Honors

Fall and Spring: 3-24 units

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24-616 Tribology-Friction, Lubrication and Wear

Intermittent: 12 units

Covers the science of surfaces interacting via dry, lubricated, and mixed (i.e., dry + lubricated) contact. Fundamental aspects include the Reynolds Equation, thermal-tribology, friction, and wear. Applied topics include bearings, surface analysis, nanomanufacturing, and biotribology. The course will conclude with a team project which will require computer programming. 4 hrs lec. Prerequisite: None

24-623 Molecular Simulation of Materials

Intermittent: 12 units

The purpose of this course is to expose engineering students to the theory and implementation of numerical techniques for modeling atomic-level behavior. The main focus is on molecular dynamics and Monte Carlo simulations. Students will write their own simulation computer codes, and learn how to perform calculations in different thermodynamic ensembles. Consideration will be given to heat transfer, mass transfer, fluid mechanics, mechanics, and materials science applications. The course assumes some knowledge of thermodynamics and computer programming. 4 hrs lec.

Prerequisite: None

24-655 Cellular Biomechanics

Intermittent: 9 units

This course discusses how mechanical quantities and processes such as force, motion, and deformation influence cell behavior and function, with a focus on the connection between mechanics and

biochemistry. Specific topics include: (1) the role of stresses in the cytoskeleton dynamics as related to cell growth, spreading, motility, and adhesion; (2) the generation of force and motion by moot molecules; (3) stretch-activated ion channels; (4) protein and DNA deformation; (5) mechanochemical coupling in signal transduction. If time permits, we will also cover protein trafficking and secretion and the effects of mechanical forces on gene expression. Emphasis is placed on the biomechanics issues at the cellular and molecular levels; their clinical and engineering implications are elucidated. 3 hrs. lec. Prerequisite: Instructor permission.

24-656 Advanced Manufacturing

Intermittent: 12 units

This course focuses on modeling of material removal processes, including the turning, milling, boring, and drilling processes. The course also includes introduction on economics of material removal, non-traditional material removal processes, stability of machining processes, tool wear and tool life, dimensional and surface metrology, and experimental methods in manufacturing. A term project that may involve experimentations is an integral part of the course. 4 hrs lec. Prerequisite: Senior or Graduate Standing

24-675 Micro/Nano Robotics

Spring: 12 units

This course focuses on the design, modeling, fabrication, and control of miniature mobile robot and micro/nano-manipulation systems for graduate and upper level undergraduate students. It provides an overview of the state-of-the-art micro- and nanoscale sensors, actuators, manipulators, energy sources, robot design, and control methods. It requires active student participation, interaction, and in-class discussions. In addition to the basic background, it includes many case studies of current miniature robots and micro/nano-systems, challenges and future trends, and potential applications. The course requires a final project involving novel theoretical and/or experimental ideas for micro/nano-robotic systems with a team of students. Depending on the equipment availability, these projects can also involve hands-on experience and experimental demonstrations. 4 hrs. lec.

Prerequisites: Permission of the instructor.

24-681 Computer-Aided Design

Intermittent: 12 units

This course is the first section of the two-semester sequence on computational engineering. Students will learn how computation and information technologies are rapidly changing the way engineering design is practiced in industry. The course covers the theories and applications of the measurement, representation, modeling, and simulation of three-dimensional geometric data used in the engineering designed process. Students taking this course are assumed to have knowledge of the first course in computer programming. 4 hrs lecture, 2 hrs computer cluster

Prerequisite: None

24-682 Computer-Aided Engineering

Intermittent: 12 units

This course is the second in the two-semester sequence on computational engineering. Students will learn how computation and information technologies are rapidly changing the way engineering analysis is practiced in industry. The course covers the theories and applications of finite element methods, finite element mesh generation, robot manipulator kinematics, and inverse kinematics, and manufacturing process optimization. Students taking this course are assumed to have knowledge of the first course in computer programming. 4 hrs lecture, 2 hrs computer cluster

Prerequisite: None

24-684 Quantitative Methods for Product Design and Development

Intermittent: 12 units

Every other spring This course introduces students to methods for quantifying engineering and market tradeoffs in product design, including: engineering design optimization model construction; product families; discrete choice models; conjoint analysis and design of experiments in survey design; basic microeconomics and econometrics as applied to design; game theory; and policy analysis. Students apply methods in a course project to coordinate engineering design of a product with measured market preferences and positioning, examining engineering tradeoffs and economic incentives. The course involves some basic programming in Matlab and Excel with tutorials provided. Assumes fluency with calculus and prior programming experience. 4 hrs. lec. Crosslisted as 24-484. Graduate students will complete an additional project. Prerequisites: Graduate standing or advanced undergraduate with permission of instructor

Materials Science & Engineering

27-052 Introduction to NanoScience and Technology

Summer: 9 units

This course is offered within Carnegie Mellon's Advanced Placement Early Admissions (APEA) program. The course is primarily intended to provide an introduction to nanoscience and technology to a wide audience of students at the advanced high school to incoming freshmen level. The course goals are twofold: (1) to provide students with a holistic view of the objectives, opportunities and challenges of the emerging field of nanotechnology and (2) to sensitize students at an early stage of their career to the relevance of the connections among the traditional disciplines as a vital element to the progress in interdisciplinary areas such as nanotechnology. The course will cover: Introduction and fundamental science; Preparation of nanostructures; Characterization of nanostructures; Application examples, Social and ethical aspects of nanotechnology. Admission according to APEA guidelines.

27-100 Engineering the Materials of the Future

Fall and Spring: 12 units

Materials form the foundation for all engineering applications. Advances in materials and their processing are driving all technologies, including the broad areas of nano-, bio-, energy, and electronic (information) technology. Performance requirements for future applications require that engineers continue to design both new structures and new processing methods in order to engineer materials having improved properties. Applications such as optical communication, tissue and bone replacement, fuel cells, and information storage, to name a few, exemplify areas where new materials are required to realize many of the envisioned future technologies. This course provides an introduction to how science and engineering can be exploited to design materials for many applications. The principles behind the design and exploitation of metals, ceramics, polymers, and composites are presented using examples from everyday life, as well as from existing, new, and future technologies. A series of laboratory experiments are used as a hands-on approach to illustrating modern practices used in the processing and characterization of materials and for understanding and improving materials' properties.

Corequisites: 21-120, 33-106

27-201 Structure of Materials

Fall: 9 units

This course covers the fundamentals of crystallography and diffraction. Topics covered include: the periodic table of the elements, bonding in different classes of materials, Bravais lattices, unit cells, directions and planes, crystal geometry computations, direct and reciprocal space, symmetry operations, point and space groups, nature of x-rays, scattering in periodic solids, Bragg's law, the structure factor, and the interpretation of experimental diffraction patterns. 24 crystal structure types of importance to various branches of materials science and engineering will be introduced. Amorphous materials, composites and polymers are also introduced. This course includes both lectures and laboratory exercises.

Prerequisites: 21122 Corequisites: 27-100

27-202 Defects in Materials

Fall: 9 units

Defects have a fundamental influence on the properties of materials. For example, the strength and deformation of materials, the electrical and optical properties of materials, and the rates of diffusion in solids are all determined by the population of intrinsic and extrinsic defects. The objective of this course is to define approaches to quantifying the populations and properties of defects in crystals. The course will be divided into three sections: point defects, dislocations, and planar defects. The formation of point defects and their influence on diffusion and electrical and optical properties will be considered. The properties and characteristics of dislocations and dislocation reactions will also be presented. Dislocations in different crystal systems and the role of dislocations in deformation will be discussed. The crystallography and energetics of planar defects and interfaces will also be described. The course includes both lectures and laboratory exercises.

Prerequisites: 21122 Corequisites: 27-100

27-205 Introduction to Materials Characterization

Spring: 3 units

The course introduces the modern methods of materials characterization, including characterization of microstructure and microchemistry of materials. A classroom component of the course will introduce the wide array of methods and applications of characterization techniques. Basic theory will be introduced where needed. Students will then be instructed in the use of

several instruments such as AFM, SEM, and EDS, using a hands-on approach. All instruments are part of the existing lab facilities within MSE and CIT. The methods learned in this course will serve the student during several other higher level courses, such as the Senior level MSE Capstone Course (27-401).

27-211 Structure of Materials (Minor Option)

6 units

This course is identical to 27-201, but without the 3-unit lab component.

27-215 Thermodynamics of Materials

Fall: 12 units

The first half of the course will focus on the laws of thermodynamics and the inter-relations between heat, work and energy. The concept of an equilibrium state of a system will be introduced and conditions which must be satisfied for a system to be at equilibrium will be established and discussed and the concepts of activity and chemical potential introduced. The second half of the course will focus on chemical reactions, liquid and solid solutions, and relationships between the thermodynamics of solutions and binary phase diagrams.

Corequisites: 21-259, 27-100

27-216 Transport in Materials

Spring: 9 units

This course is designed to allow the student to become familiar with the fundamental principles of heat flow, fluid flow, mass transport and reaction kinetics. In addition, the student will develop the skills and methodologies necessary to apply these principles to problems related to materials manufacture and processing. Topics will include thermal conductivity, convection, heat transfer equations, an introduction to fluid phenomena viscosity, etc., Newtons and Stokes Laws, mass momentum balances in fluids, boundary layer theory, diffusion and absolute reaction rate theory. Where appropriate, examples will be taken from problems related to the design of components and the processing of materials.

Prerequisites: 15100 and 27215

27-217 Phase Relations and Diagrams

Spring: 12 units

Stability of structures. Hume-Rothery rules. Free energy-composition curves with applications to binary and ternary phase diagrams. Quantitative concepts of nucleation and growth with examples from solidification. Development of microstructures in various classes of phase diagram under near-equilibrium conditions. Atomic mechanisms of solid state diffusion and approach to equilibrium through diffusion.

Prerequisites: 27201 and 27202 and 27215 Corequisites: 09-105

27-299 Professional Development I

Fall: 1 units

This is a course that is designed to teach engineering business and professional skills to the MSE students. It is attended by sophomores, juniors and seniors and the courses Professional Topics I, II and III are given once per year on a three year cycle. Year 1: Work Place Skills, Leadership Skills and Teams Year 2: Project Management Year 3: Ethics, Business Planning, Lifetime Learning Although the course is not specifically designed as "metals, polymers, ceramics and composites", real world problems are used for examples and discussions. Assignments, when used, (for example, in project management or business planning) can be case studies or typical assignments a materials scientist may encounter during his/her employment.

27-301 Microstructure and Properties I

Fall: 9 units

The objective of this courses and its companion 27-302 is to convey some of the essential concepts in materials science and engineering that relate material properties (strength, magnetism, thermal expansion) to microstructure (crystal structure, dislocations structure, grain structure, precipitate structure, composite structure) in single phase materials. The relationships will be illustrated with examples of both idealized and technological materials. The course will draw upon many aspects of materials science such as defects, phase transformations etc. The course includes both lectures and laboratory exercises.

Prerequisites: 27216 and 27217 and 33107

27-302 Microstructure and Properties II

Spring: 9 units

This course applies the principles and ideas developed in 27-301 to multiphase materials. The structure-property relationships will be illustrated with examples of both idealized and technological materials. The course will draw upon many aspects of materials

science such as defects, phase transformations etc. The course includes both lectures and laboratory exercises.

Prerequisites: 27301 Corequisites: 27-301

27-311 Polymeric Biomaterials

Spring: 9 units

This introductory course will address basic and applied concepts of polymers as biomaterials. The students will be exposed to both fundamental synthetic mechanisms of polymers and their physical and chemical properties. Specific emphasis will be placed on biodegradation mechanisms, mechanical properties and surface chemistry of polymeric materials. Cellular interactions with various surfaces and immunological responses will be covered. Applications of biomaterials to be discussed include tissue engineering and artificial organs.

Prerequisites: None, but 09-105 Introduction to Modern Chemistry and 42-101 Introduction to Biomedical Engineering will be useful

27-312 Metallic and Ceramic Biomaterials

Fall: 9 units

The course addresses basic and applied concepts of metals and ceramics as biomaterials. The students will be exposed to the principles, properties and applications of amorphous and crystalline inorganic and metallic systems for biological applications. Specific emphasis will be placed on processing biochemical activity, biodegradation mechanisms, and various properties relevant for biological response. Cellular interactions with various surfaces and immunological responses will also be covered. Applications of biomaterials to be discussed include tissue engineering, artificial implants and devices. Part I of this course is offered in the Spring and focuses on the principles, properties and applications of polymers as biomaterials.

Prerequisites: None, but 09-105 Introduction to Modern Chemistry and 42-101 Introduction to Biomedical Engineering will be useful.

27-322 Processing of Metals

Fall: 9 units

This course addresses the principles of processing of metals and the relationship between processing and performance. Topics include include chemical thermodynamics, reaction kinetics, surfaces, fundamentals of heat treatment, process engineering, powder handling, powder compaction, densification and sintering. These aspects of processing science will be applied to the processing of metals including electrometallurgy, hydrometal-lurgy, pyrometallurgy, extraction, refining, and specific examples of alloy systems such as the production of steel, aluminum or titanium. The principles and practice of materials processing will be applied to process optimization. The relationship between processing methods and the environment will be discussed. The impact of the processing history of materials will be discussed in relation to material performance and lifetime. The concept of the lifecycle of materials will be discussed.

27-323 Powder Processing of Materials

Fall: 9 units

This course addresses the methods used in, and the principles that underlie, powder processing of metals and ceramics. Aspects of powder processing will be discussed in relation to the use of materials in engineering applications. The relationship between processing methods and materials performance in select applications will be discussed using specific materials examples including metals and ceramics. The course is broken down into three main parts: (1) understanding, selecting, and controlling powder characteristics; (2) powder handling, compaction, and forming techniques; and (3) drying, burnout, densification, sintering, and grain growth in powder compacts. Topics include chemical thermodynamics, reaction kinetics, surfaces, colloids, dispersions, process engineering, powder handling, powder compaction, shape forming, densification, and sintering.

Prerequisites: 27100 and 27202 and 27215 and 27216

27-324 Introduction to Polymer Science and Engineering

Fall: 9 units

This course introduces the fundamental properties of polymer materials and the principles underlying the design as well as the engineering and manufacturing of polymer materials. The basic characteristics of macromolecules will be discussed followed by an introduction to relevant forming technologies and their significance to material performance. Technologically relevant engineering properties of polymer materials will be introduced with focus on mechanical, electrical, and optical properties. Selected case studies and design projects will introduce students to the various stages of technical product development, i.e. problem analysis, material selection and processing plan.

27-325 Polymer Physics and Morphology

Fall: 9 units

This course introduces the fundamental concepts necessary to understand the structure of polymers in the solid state. The structure of polymers will be discussed with focus on the amorphous, crystalline and liquid-crystalline state. One aim is to provide the student intuition about the organization of polymer molecules in the solid state based on the polymer's chemical structure. Attention will be given to the phenomenon of glass transition in amorphous polymers as well as the morphology and kinetics of crystal formation in semi-crystalline polymers. The second part of the course will focus on polymer multicomponent materials. Basic concepts of lattice models will be introduced and applied to predict the phase behavior of polymer blends. A last section will focus on microdomain formation in block copolymer materials.

27-357 Introduction to Materials Selection

Spring: Mini Session - 6 units

This course introduces the student to the methodology by which a material can be successfully chosen for a given application from the various classes (metals, ceramics and glasses, electronic materials, polymers and composites). Criteria for selection include processing methods, fabrication of materials systems, costs, specifications and standards, environmental considerations, ethics, and substitutions for strategic materials. Common causes of failure and methods of prevention will be discussed. Each student will have the opportunity for an original paper with specialization in a material class of choice.

27-367 Selection and Performance of Materials

Spring: 6 units

This course involves the application of materials and process selection methodologies used in product design. These methodologies are based upon the integration of function, shape, material, and process and are used to select materials and processes for a variety of product applications (electronic, magnetic, mechanical, optical, thermal, etc.) from amongst the entire spectrum of engineering materials (elastomers, ceramics, glasses, polymers, metals, and composites). Other factors in the selection process include engineering economics, codes and standards, environmental and safety regulations, professional ethics, and life cycle analysis. Common causes of failure and methods of prevention are evaluated as one stepping-stone to a final project: the selection of a material or process for a new product or for an improved existing product. There is extensive use of the Ashby Materials Selection Software throughout the course.

Prerequisites: 27100

27-399 Professional Development II

Fall: 1 units

This is a course that is designed to teach engineering business and professional skills to the MSE students. It is attended by sophomores, juniors and seniors and the courses Professional Topics I, II and III are given once per year on a three year cycle. Year 1: Work Place Skills, Leadership Skills and Teams Year 2: Project Management Year 3: Ethics, Business Planning, Lifetime Learning Although the course is not specifically designed as "metals, polymers, ceramics and composites", real world problems are used for examples and discussions. Assignments, when used, (for example, in project management or business planning) can be case studies or typical assignments a materials scientist may encounter during his/her employment.

27-401 MSE Capstone Course I

Fall: 12 units

This capstone course introduces the student to the methodology by which a material can be successfully chosen for a given application from the various classes (metals, ceramics and glasses, electronic materials, polymers and composites). Criteria for selection include processing methods, fabrication of materials systems, costs, specifications and standards, environmental considerations, ethics, and substitutions for strategic materials. Common causes of failure and methods of prevention will be discussed. Each student will have the opportunity for an original paper with specialization in a material class of choice.

Prerequisites: 27301

27-402 MSE Capstone Course II

Spring: 12 units

This capstone course continues the discussion of materials selection and performance with an emphasis on design of components and systems. As in the companion course, the full range of tools for understanding materials structure, processing and properties are applied to optimizing materials performance in current engineering applications. The paper from the companion course will be expanded into a project. Prerequisites: 27401

27-405 Analysis and Prevention of Product Failures

Intermittent: 9 units

This course focuses on detailed case studies of failures such as recent structural collapses, heart valve fractures, and the sinking of the Titanic. A central focus of all analyses is the determination of the principal cause or causes of failure. These detailed causation determinations will involve techniques ranging from fault tree analysis to fractography by optical and scanning electron microscopy to stress analysis using finite element analysis. The current and potential future role of failure analysis and prevention in regulation and litigation will also be considered in detail, again using technology rich case studies. The final product is an analysis of a specific product failure that is both broadly based and technologically rigorous, combined with a strategy or strategies for its prevention. Prerequisites: 27-100 or permission of instructor

27-410 Computational Techniques in Engineering

Spring: 9 units

This course develops the methods to formulate basic engineering problems in a way that makes them amenable to computational/numerical analysis. The course will consist of three main modules: basic programming skills, discretization of ordinary and partial differential equations, and numerical methods. These modules are followed by two modules taken from a larger list: Monte Carlo-based methods, molecular dynamics methods, image analysis methods, and so on. Students will learn how to work with numerical libraries and how to compile and execute scientific code written in Fortran-90 and C++. Students will be required to work on a course project in which aspects from at least two course modules must be integrated.

27-421 Processing Design

Fall: Mini Session - 6 units

In this course, the concepts of materials and process design are developed, integrating the relevant fundamental phenomena in a case study of a process design. The course includes basic science and engineering as well as economic and environmental considerations. The case study is on environmentally acceptable sustainable steelmaking. Other case studies in materials processing could be used.

27-432 Electronic and Thermal Properties of Metals, Semiconductors and Related Devices

Intermittent: 9 units

Fall even years This is Part I of a two-part course (Part II is 27-433) sequence concerned with the electrical, dielectric, magnetic and superconducting properties of materials. Students taking Part I will develop an in-depth understanding, based on the modern theories of solids, of the electrical, electronic and thermal properties of metals and semiconductors and the principles of operation of selected products and devices made from these materials. Overarching and interrelated topics will include elementary quantum and statistical mechanics, relationships between chemical bonds and energy bands in metals and semiconductors, the roles of phonons and electrons in the thermal conductivity of solids, diffusion and drift of electrons and holes, the important role of junctions in the establishment and control of electronic properties of selected metal- and semiconductor-based devices. Examples of commercial products will be introduced to demonstrate the application of the information presented in the text and reference books and class presentations. Additional topics will include microelectro-mechanical systems and nanoelectronics.

27-433 Dielectric, Magnetic, Superconducting Properties of Materials & Related Devices

Intermittent: 9 units

Fall odd years: 9 units This is Part II of a two-part course sequence (Part I is 27-432) concerned with the electrical, dielectric, magnetic and superconducting properties of materials. Students taking Part II will develop an in-depth understanding, based on the modern theories of solids, of the dielectric, magnetic and superconducting properties of materials and the principles of operation of selected products and devices made from these materials. Topics will include relationships between chemical bonds and energy bands in dielectric and magnetic materials; polarization mechanisms in materials and their relationship to capacitance, piezoelectricity, ferroelectricity, and pyroelectricity; magnetization and its classification among materials; magnetic domains; soft and hard magnets; and the origin, theory and application of superconductivity. Examples of commercial products will be introduced to demonstrate the application of the information presented in the text and reference books and class presentations.

27-445 Structure, Properties and Performance Relationships in Magnetic Materials

Spring: 9 units

This course introduces the student to intrinsic properties of magnetic materials including magnetic dipole moments, magnetization, exchange coupling, magnetic anisotropy and magnetostriction. This is followed by discussion of extrinsic properties including magnetic hysteresis, frequency dependent magnetic response and magnetic losses. This will serve as the basis for discussing phase relations and structure/properties relationships in various transition metal magnetic materials classes including iron, cobalt and nickel elemental magnets, iron-silicon, iron-nickel, iron-cobalt and iron platinum. This will be followed by a discussion of rare earth permanent magnets, magnetic oxides, amorphous and nanocomposite magnets. Polymers used in magnetic tape applications will also be covered.

27-454 Supervised Reading

All Semesters: 3-12 units

This course provides the opportunity for a detailed study of the literature on some subject under the guidance of a faculty member, usually but not necessarily in preparation for the Capstone Course, 27-401/402.

27-499 Professional Development III

Fall: 1 units

This is a course that is designed to teach engineering business and professional skills to the MSE students. It is attended by sophomores, juniors and seniors and the courses Professional Topics I, II and III are given once per year on a three year cycle. Year 1: Work Place Skills, Leadership Skills and Teams Year 2: Project Management Year 3: Ethics, Business Planning, Lifetime Learning Although the course is not specifically designed as "metals, polymers, ceramics and composites", real world problems are used for examples and discussions. Assignments, when used, (for example, in project management or business planning) can be case studies or typical assignments a materials scientist may encounter during his/her employment.

27-530 Advanced Physical Metallurgy

Fall: 9 units

The purpose of this course is to develop a fundamental understanding of the evolution of microstructure in engineering alloys and how desired mechanical and physical properties can be obtained by control of microstructure. The first part of the course considers phase stability, phase diagrams and the thermodynamics, mechanisms and kinetics of phase transformations. The second part of the course concerns property/microstructure relationships in engineering alloys and how the concepts covered in the first part of the course can be used to obtain the desired microstructures.

27-533 Principles of Growth and Processing of Semiconductors

Fall: Mini Session - 6 units

Development of a fundamental understanding of material principles governing the growth and processing of semiconductors. Techniques to grow and characterize bulk crystals and epitaxial layers are considered. The processing of semiconductors into devices and the defects introduced thereby are discussed. The roles of growth- and processing-induced defects in determining long term reliability of devices are examined.

27-542 Processing and Properties of Thin Films

Fall: 9 units

This course is designed to provide an introduction to the science and technology of thin films, with special emphasis on methods to produce thin films and relationships between growth conditions and thin film properties. Topics include (1) various methods of thin film production, such as evaporation, sputtering and chemical vapor deposition, (2) nucleation and growth processes, (3) dimensional, chemical, and structural characterization of thin films and (4) properties and applications, such as optical properties and liquid crystal displays.

27-551 Properties of Ceramics and Glasses

Spring: 9 units

This course focuses on the diverse properties of ceramics and glasses. It includes discussions of thermal properties, such as heat capacity and thermal expansion; mechanical properties of ceramics and glasses, such as strength, toughness and environmental effects; electrical properties including electronic and ionic conductivity, dielectric properties, piezoelectricity, and ferroelectricity; and optical properties as they pertain to glasses. The course also includes a discussion of selected current applications, such as recent trends in ceramic multi-layer packaging for electronics, advanced structural ceramics for automotive engines, and ceramic ferrites

in phased-array radar systems. Numerous examples are used throughout the course to illustrate the engineering relevance of fundamental phenomena. This class will be co-taught with 27-571. Undergraduates taking the course will have separate homeworks and exams from the graduate students and will be graded separately from the graduate students.

27-555 Materials Project I

Fall: 6,9 units

This course is designed to give experience in individualized research under the guidance of a faculty member. The topic is selected by mutual agreement, and will give the student a chance to study the literature, design experiments, interpret the results and present the conclusions orally and in writing.

27-556 Materials Project II

Spring: 6,9 units

Second semester of Materials Project. This course is designed to give experience in individualized research under the guidance of a faculty member. The topic is selected by mutual agreement, and will give the student a chance to study the literature, design experiments, interpret the results and present the conclusions orally and in writing.

27-565 Nanostructured Materials

Intermittent: 9 units

Fall even years: This course is an introduction to nanostructured materials or nanomaterials. Nanomaterials are objects with sizes larger than the atomic or molecular length scales but smaller than microstructures with at least one dimension in the range of 1-100 nm. The physical and chemical properties of these materials are often distinctively different from bulk materials. This course introduces the basic thermodynamic concepts related to the phases, chemical activity and synthesis of nanomaterials including metallic, semiconductor, inorganic, liquid crystalline, polymeric and surfactant systems. The characterization of the structure of nanomaterials and their applications are also explored. At the end of the course, students should understand the relationship between the nanoscale structures, properties and performance of nanomaterials.

27-566 Special Topics in MSE

Fall and Spring: 9 units

This course is offered occasionally to present one or more topics, usually of timely or of practical engineering importance. Interested students should check with the Department to determine whether the course is being offered, and to obtain a syllabus if appropriate.

27-582 Phase Transformations in Solids

Intermittent: 9 units

Spring even years: In this course the fundamental aspects of solid state phase transformations are presented. The nucleation (homogeneous and heterogeneous) and growth of diffusional and non-diffusional heterogeneous solid state transformations are discussed from the point of view of crystallography, thermodynamics and kinetics, as are the same aspects of homogeneous transformations. Details of such transformations as precipitation, cellular, atomic ordering, massive, spinodal decomposition, displacive, etc. are discussed with specific examples from the Materials Science literature.

27-591 Mechanical Behavior of Materials

Intermittent: 9 units

Spring odd years: Fundamentals of stress and strain. Linear elastic behavior. Tensile testing and yield criteria. Relationships between stress and strain for the case of plastic deformation. Theoretical strength. Tensile tests of single crystals and the idea of a slip system. Shear stress versus shear strain curves for single crystals and the effects of crystal orientation, temperature, atoms in solid solution and precipitates on the shapes of such curves. Taylor's connection between tensile curves of single crystals and those of polycrystalline samples. Dislocations and plastic deformation. Strengthening mechanisms including solid-solution strengthening, strengthening by precipitates, work hardening and grain size effects on strength. Approaches to quantifying the fracture resistance of materials, including the Griffith approach, the energy release rate approach and the stress intensity factor approach. Crack tip behavior including stresses and strains at crack tips and the plastic zone. Fracture mechanisms including ductile fracture, cleavage fracture and intergranular fracture. The fracture of highly brittle materials. Time permitting fatigue and creep of materials will be discussed.

27-592 Solidification Processing

Intermittent: 9 units

Spring odd years: The goal of this course is to enable the student to solve practical solidification processing problems through the

application of solidification theory. The objectives of this course are to: (1) Develop solidification theory so that the student can understand predict solidification structure; (2) Develop a strong understanding of the role of heat transfer in castings; (3) Develop an appreciation for the strengths and weaknesses of a variety of casting processes. The first half of the course will be theoretical, covering nucleation, growth, instability, solidification microstructure: cells, dendrites, eutectic and peritectic structures, solute redistribution, inclusion formation and separation, defects and heat transfer problems. The second part of the course will be process oriented and will include conventional and near net shape casting, investment casting, rapid solidification and spray casting where the emphasis will be on process design to avoid defects.

27-594 Electrochemical Processes in Materials

Intermittent: 9 units

Spring Even Years: This undergraduate course is designed to provide an introduction to electrochemistry in materials science. The fundamentals of electrochemical cells, electrode kinetics will be introduced along with electrochemical techniques such as potentiostatic, galvanostatic and electrochemical impedance spectroscopy. Electrochemical applications that will be discussed will include: corrosion, electrochemical processing of materials and electrochemically based devices such as fuel cells, batteries and sensors.

Prerequisites: 27215

Military Science-ROTC

30-101 Introduction to Military Leadership

Fall: 5 units

In this course, students will be introduced to the fundamentals of Army leadership, management and basic military skills. The course emphasizes the Army's "Principles of Leadership" and familiarizes the student with rifle marksmanship, orienteering and map reading, rappelling, basic lifesaving skills and the wear of the Army uniform. In addition, students will enhance their time management, decision-making and physical fitness abilities. Each student must participate in physical training, field training exercises and is expected to wear the Army uniform, which will be provided.

30-102 Foundations of Leadership

Spring: 5 units

This course is a continuation of the subjects and skills taught in 30101. In addition to extending the student's abilities in the areas of leadership, orienteering and map reading, lifesaving and other basic military concepts, the course also introduces the student to the employment of military units. Individual topics covered include the Army's emerging technological enhancements, the Army organization and structure and the wartime policies and principles. Each student must participate in physical training, field training exercises and is expected to wear the Army uniform, which will be provided.

30-201 Leadership Dynamics and Application

Fall: 5 units

In this course, students will delve more deeply into the Army's leadership and management techniques, including the application of those techniques in faculty-supervised practical exercises. The course also seeks to enhance the student's abilities in orienteering and map reading, terrain analysis, advanced lifesaving techniques and physical fitness. Students are introduced to the values that define the United States Army as an American institution, and each student continues to enhance his or her physical development under the supervision of the faculty. Each student must participate in physical training, field training exercises and is expected to wear the Army uniform, which will be provided.

30-202 Applications in Leadership and Combat Power

Spring: 5 units

This course continues the study of the topics covered in 30201 and focuses upon practical application of the leadership and management techniques learned in the fall semester. The student develops and applies advanced map reading, terrain analysis, problem-solving and decision-making skills in practical exercises. Additionally, the student is introduced to the Army's formal orders process, used to maneuver and sustain Army forces on the modern battlefield. Each student must participate in physical training, field training exercises and is expected to wear the Army uniform, which will be provided.

30-205 Self Development Survey Skills

All Semesters: 3 units

Self Dev Survey Skills

30-301 Basic Leader Planning and Combat Operations

Fall: 5 units

This course offers an in-depth analysis and focused practical application of leadership and management techniques. The emphasis in the course is on leader development and the goal is to enhance the student's ability to perform effectively in a stressful decision-making environment. As such, time management, decision-making, advanced military skills, troop-leading procedures and advanced physical training are emphasized. The course requires participation in a demanding physical training program to prepare contracted students for the Army's R.O.T.C. Leader Development and Assessment Course (LDAC). Each student must participate in field training exercises and is expected to wear the Army uniform, which will be provided. Prerequisites: Class is open only to contracted students. Veterans with two or more years of service may enroll with approval.

30-302 Advanced Leader Planning and Combat Operations

Spring: 5 units

This course builds upon the foundation laid in the fall semester with the objective of fully preparing contracted students for participation in the Army's challenging R.O.T.C. Leader Development and Assessment Course (LDAC). The course extends and enhances the student's leadership, management, communication, fitness and basic military skills in preparing the student for commissioning as an officer in the United States Army. Practical exercises are used to reinforce all of the skills that the student has developed over the course of the military science instruction. Each student must participate in physical training, field training exercises and is expected to wear the Army uniform, which will be provided. Prerequisites: Class is open only to contracted students. Veterans with two or more years of service may enroll with approval.

30-401 Progressive Leadership Theory and Applications

Fall: 5 units

This course is the first of two semester courses that serve as a capstone designed to transition the student from cadet to U.S. Army officer. Students are assigned to command and staff positions within the cadet battalion, corresponding to those found in United States Army units. Students perform the duties of the staff or command as assigned and interact with the other cadets as part of a functioning command organization. In addition to studying the operations and organizations of the U.S. Army, students are required to plan and execute the required training and activities in leading the underclass cadets. A variety of topics of current interest are covered. Guest speakers are commonly invited to discuss their military experiences or their perspectives on military-related topics. Each student must participate in physical training, field training exercises and is expected to wear the Army uniform, which will be provided. Prerequisites: Class is open only to contracted students.

30-402 Transition to the Profession of Arms

Spring: 5 units

This capstone course completes the transition from cadet to Army officer and concludes with the student's commissioning into the United States Army. During the semester, students continue to act in accordance with their assigned staff and command responsibilities and they prepare for their duties as a Lieutenant in the Army. This course covers personal and performance counseling, evaluation of subordinate leaders and team-building skills as well as military justice and discipline. Students bring to bear all of the skills and knowledge that they have accrued over the prior semesters in the Department of Military Science. Each student must participate in physical training, field training exercises and is expected to wear the Army uniform, which will be provided. Prerequisites: Class is open only to contracted students.

Aerospace Studies-ROTC**31-101 Foundations of the United States Air Force**

Fall: 3 units

AS100 is a survey course designed to introduce cadets to the United States Air Force and Air Force Reserve Officer Training Corps. Featured topics include: mission and organization of the Air Force, officership and professionalism, military customs and courtesies, Air Force officer opportunities, and an introduction to communication skills. Leadership Laboratory is mandatory for AFROTC cadets and complements this course by providing cadets with followership experiences.

31-102 Foundations of the United States Air Force

Spring: 3 units

AS100 is a survey course designed to introduce cadets to the United States Air Force and Air Force Reserve Officer Training Corps.

Featured topics include: mission and organization of the Air Force, officership and professionalism, military customs and courtesies, Air Force officer opportunities, and an introduction to communication skills. Leadership Laboratory is mandatory for AFROTC cadets and complements this course by providing cadets with followership experiences.

31-105 Air Force Leadership Laboratory

All Semesters: 0 units

The AS100 and AS200 Leadership Laboratory courses (LLABs) include a study of Air Force customs and courtesies, drill and ceremonies, and military commands. The LLAB also includes studying the environment of an Air Force officer and learning about areas of opportunity available to commissioned officers. The AS300 and AS400 LLABs consist of activities classified as leadership and management experiences. They involve the planning and controlling of military activities of the cadet corps, and the preparation and presentation of briefings and other oral and written communications. LLABs also include interviews, guidance, and information, which will increase the understanding, motivation, and performance of other cadets.

31-106 Air Force Leadership Laboratory

All Semesters: 0 units

The AS100 and AS200 Leadership Laboratory courses (LLABs) include a study of Air Force customs and courtesies, drill and ceremonies, and military commands. The LLAB also includes studying the environment of an Air Force officer and learning about areas of opportunity available to commissioned officers. The AS300 and AS400 LLABs consist of activities classified as leadership and management experiences. They involve the planning and controlling of military activities of the cadet corps, and the preparation and presentation of briefings and other oral and written communications. LLABs also include interviews, guidance, and information, which will increase the understanding, motivation, and performance of other cadets.

31-107 Air Force Leadership Laboratory

All Semesters: 0 units

The AS100 and AS200 Leadership Laboratory courses (LLABs) include a study of Air Force customs and courtesies, drill and ceremonies, and military commands. The LLAB also includes studying the environment of an Air Force officer and learning about areas of opportunity available to commissioned officers. The AS300 and AS400 LLABs consist of activities classified as leadership and management experiences. They involve the planning and controlling of military activities of the cadet corps, and the preparation and presentation of briefings and other oral and written communications. LLABs also include interviews, guidance, and information, which will increase the understanding, motivation, and performance of other cadets.

31-108 Air Force Leadership Laboratory

All Semesters: 0 units

The AS100 and AS200 Leadership Laboratory courses (LLABs) include a study of Air Force customs and courtesies, drill and ceremonies, and military commands. The LLAB also includes studying the environment of an Air Force officer and learning about areas of opportunity available to commissioned officers. The AS300 and AS400 LLABs consist of activities classified as leadership and management experiences. They involve the planning and controlling of military activities of the cadet corps, and the preparation and presentation of briefings and other oral and written communications. LLABs also include interviews, guidance, and information, which will increase the understanding, motivation, and performance of other cadets.

31-201 The Evolution of Air and Space Power

Fall: 3 units

The AS200 course designed to examine general aspects of air and space power through a historical perspective. Utilizing this perspective, the course covers a time period from the first balloons and dirigibles to the space-age global positioning systems of the Persian Gulf War. Historical examples are provided to extrapolate the development of Air Force capabilities (competencies), and missions (functions) to demonstrate the evolution of what has become today's USAF air and space power. Furthermore, the course examines several fundamental truths associated with war in the third dimension: e.g. Principles of War and Tenets of Air and Space Power. As a whole, this course provides the cadets with a knowledge level understanding for the general element and employment of air and space power, from an institutional doctrinal and historical perspective. In addition, the students will continue to discuss the importance of the Air Force Core Values with the use of operational examples and historical Air Force leaders and will continue to develop their communication skills. Leadership Laboratory is mandatory for AFROTC cadets and complements this course by providing cadets with followership experiences.

31-202 The Evolution of Air and Space Power

Spring: 3 units

The AS200 course designed to examine general aspects of air and space power through a historical perspective. Utilizing this perspective, the course covers a time period from the first balloons and dirigibles to the space-age global positioning systems of the Persian Gulf War. Historical examples are provided to extrapolate the development of Air Force capabilities (competencies), and missions (functions) to demonstrate the evolution of what has become today's USAF air and space power. Furthermore, the course examines several fundamental truths associated with war in the third dimension: e.g. Principles of War and Tenets of Air and Space Power. As a whole, this course provides the cadets with a knowledge level understanding for the general element and employment of air and space power, from an institutional doctrinal and historical perspective. In addition, the students will continue to discuss the importance of the Air Force Core Values with the use of operational examples and historical Air Force leaders and will continue to develop their communication skills. Leadership Laboratory is mandatory for AFROTC cadets and complements this course by providing cadets with followership experiences.

31-301 Air Force Leadership Studies

Fall: 9 units

AS300 is a study of leadership, management fundamentals, professional knowledge, Air Force personnel and evaluation systems, leadership ethics, and the communication skills required of an Air Force junior officer. Case studies are used to examine Air Force leadership and management situations as a means of demonstrating and exercising practical application of the concepts being studied. A mandatory Leadership Laboratory complements this course by providing advanced leadership experiences in officer-type activities, giving students the opportunity to apply the leadership and management principles of this course.

31-302 Air Force Leadership Studies

Spring: 9 units

AS300 is a study of leadership, management fundamentals, professional knowledge, Air Force personnel and evaluation systems, leadership ethics, and the communication skills required of an Air Force junior officer. Case studies are used to examine Air Force leadership and management situations as a means of demonstrating and exercising practical application of the concepts being studied. A mandatory Leadership Laboratory complements this course by providing advanced leadership experiences in officer-type activities, giving students the opportunity to apply the leadership and management principles of this course.

31-401 National Security Affairs and Preparation for Active Duty

Fall: 9 units

AS400 examines the national security process, regional studies, advanced leadership ethics, and Air Force doctrine. Special topics of interest focus on the military as a profession, officership, military justice, civilian control of the military, preparation for active duty, and current issues affecting military professionalism. Within this structure, continued emphasis is given to refining communication skills. A mandatory Leadership Laboratory complements this course by providing advanced leadership experiences, giving students the opportunity to apply the leadership and management principles of this course.

31-402 National Security Affairs and Preparation for Active Duty

Spring: 9 units

AS400 examines the national security process, regional studies, advanced leadership ethics, and Air Force doctrine. Special topics of interest focus on the military as a profession, officership, military justice, civilian control of the military, preparation for active duty, and current issues affecting military professionalism. Within this structure, continued emphasis is given to refining communication skills. A mandatory Leadership Laboratory complements this course by providing advanced leadership experiences, giving students the opportunity to apply the leadership and management principles of this course.

Naval Science - ROTC**32-100 Naval Laboratory**

Spring: 3 units

Military drill, physical fitness, and leadership seminars.

32-101 Introduction to Naval Science

Spring: 6 units

A general introduction to the naval profession and to concepts of Seapower. Instruction emphasizes the mission, organization,

and warfare components of the Navy and Marine Corps. Included is an overview of officer and enlisted ranks and rates, training and education, and career patterns. The course also covers naval courtesy and customs, military justice, leadership, and nomenclature. This course exposes the student to the professional competencies required to become a naval officer.

32-102 Seapower and Maritime Affairs

Spring: 6 units

This course surveys US naval history from its European origins to the present with emphasis on major developments and the geopolitical forces shaping these developments. Also included is discussion of the theories and writings of naval historian and strategist Alfred Thayer Mahan. The course will finish by covering present day concerns in seapower and maritime affairs including the economic and political issues of merchant marine commerce, the law of the sea, the navy and merchant marine of the former Soviet Union (FSU), and a comparison of US and FSU maritime strategies to include the rise and decline of the Soviet Navy.

32-200 Naval Laboratory

Spring: 3 units

Military drill, physical fitness, and leadership seminars.

32-201 Leadership & Management

Fall: 9 units

This course is a comprehensive advanced-level study of organizational behavior and management. Topics include a survey of the management functions of planning, organizing, and controlling; an introduction to individual and group behavior in organizations; an extensive study of motivation and leadership. Major behavioral theories are explored in detail. Practical applications are explored by the use of experiential exercises, case studies, and laboratory discussions. Other topics developed include decision-making, communication, responsibility, authority and accountability.

32-202 Naval Ships Systems I

Spring: 9 units

A detailed study of ship characteristics and types including ship design, hydrodynamic forces, stability, compartmentalization, propulsion, electrical and auxiliary systems, interior communications, ship control, and damage control. Included are basic concepts of the theory and design of steam, gas turbine, internal combustion, and nuclear propulsion. Shipboard safety and firefighting are also discussed.

32-300 Naval Laboratory

Spring: 3 units

Military drill, physical fitness, and leadership seminars.

32-302 Navigation and Naval Operations II

Spring: 9 units

A study of the international and inland rules of the nautical road, relative motion, vector analysis theory, relative motion problems, formation tactics, and ship employment. Also included is an introduction to naval operations and shipboard evolutions, vessel behavior and characteristics in maneuvering, applied aspects of ship handling, and afloat communications.

32-310 Evolution Of Warfare

Spring: 9 units

This course is to provide the student with a very basic understanding of the art and concepts of warfare from the beginning of recorded history to the present day. The intent of the curriculum is to familiarize the student with an understanding of the threads of continuity and the interrelations of political, strategic, operational, tactical, and technical levels of war from the past, while bringing into focus the application of these same principles and concepts to the battlefields of today and the future.

32-400 Naval Laboratory

Spring: 3 units

Military drill, physical fitness, and leadership seminars.

32-401 Naval Ships Systems II

Fall: 9 units

This course outlines the theory and employment of weapons systems. The student explores the processes of detection, evaluation, threat analysis, weapon selection, delivery, guidance and explosives. Fire control systems and major weapon types are discussed, including capabilities and limitations. The physical aspects of radar and underwater sound are described in detail. The facets of command, control, and communications are explored as a means of weapons system integration.

32-402 Leadership and Ethics

Spring: 6 units

The study of naval junior officer responsibilities. The course exposes the student to a study of ethics, decision making and responsibility as well as counseling methods, military justice administration, naval human resources management, directives and correspondence, naval personnel administration, material management and maintenance and supply systems. This capstone course in the NROTC curriculum builds on and integrates the professional competencies developed in prior course work and professional training.

32-410 Amphibious Warfare

Fall and Spring: 9 units

A historical survey of the development of amphibious doctrine and the conduct of amphibious operations. Emphasis is placed on the evolution of amphibious warfare in the twentieth century, especially during World War II. Focus is applied to four main themes: political/strategic situation, sea-to-land transitions, tactics ashore, and development of amphibious technology. Present day potential and limitations on amphibious operations, including the rapid deployment force concept, are explored.

Physics**33-100 Basic Experimental Physics**

All Semesters: 6 units

This course provides students with a basic introduction to experimental physics. The content of the course and the particular experiments to be carried out are chosen to be especially useful for students who intend to work in the health sciences. Specific topics will range from mechanics to nuclear and atomic physics.

33-101 Physics First Year Seminar: Science and Science Fiction

Fall: Mini Session - 3 units

Various seminars are offered that introduce first-year students to current topics of modern physics. These are mini courses that meet for half a semester. In the past, seminar topics have included: Science and Science Fiction, Astrophysics, Black Holes, Cosmology and Supernovae, Elementary Particles, and The Building Blocks of Matter. These seminars are open only to MCS first year students.

33-104 Experimental Physics

All Semesters: 9 units

This course provides first year students and sophomores with an introduction to the methods of experimental physics. Particular emphasis is placed on three aspects of experimentation: laboratory technique, including both the execution and the documentation of an experiment; data analysis, including the treatment of statistical and systematic errors and computer-aided analysis of experimental data; and written communication of experimental procedures and results. The concepts and skills for measurement and data analysis are acquired gradually through a series of experiments covering a range of topics from mechanics to nuclear and atomic physics.

33-106 Physics I for Engineering Students

All Semesters: 12 units

This is a first semester, calculus-based introductory physics course. Basic principles of mechanics and thermodynamics are developed. Topics include vectors, displacement, velocity, acceleration, force, equilibrium, mass, Newton's laws, gravitation, work, energy, momentum, impulse, temperature, heat, equations of state, thermodynamic processes, heat engines, refrigerators, first and second laws of thermodynamics, and the kinetic theory of gases. Corequisites: 21-120

33-107 Physics II for Engineering Students

All Semesters: 12 units

This is the second half of a two-semester calculus-based introductory physics sequence for engineering students. One fifth of the course covers waves, including standing and travelling waves, superposition, beats, reflection, and interference. Two fifths of the course covers electricity, including electrostatics and electric fields, Gauss' law, electric potential, and simple circuits. The remaining two fifths cover magnetism, including magnetic forces, magnetic fields, induction and electromagnetic radiation. Prerequisites: 21120 and 33106 Corequisites: 21-122

33-111 Physics I for Science Students

Fall and Spring: 12 units

This calculus based course combines the basic principles of mechanics with some quantum physics and relativity to explain nature on both a microscopic and macroscopic scale. The course will build models to describe the universe based on a small number

of fundamental physics principles. Some simple computer modeling will be done to develop insight into the solving of problems using Newton's laws. Topics covered will include vectors, momentum, force, gravitation, oscillations, energy, quantum physics, center of mass motion, angular momentum, statistical physics, and the laws of thermodynamics. No computer experience is needed. Corequisites: 21-120

33-112 Physics II for Science Students

Fall and Spring: 12 units

This is the second semester course that follows 33-111. Electricity and magnetism is developed, including the following topics: Coulomb's law, polarization, electric field, electric potential, DC circuits, magnetic field and force, magnetic induction, and the origins of electromagnetic waves.

Prerequisites: 21120 and 33111 Corequisites: 21-122

33-114 Physics of Musical Sound

Spring: 9 units

An introduction to the physics and psychophysics of musical sound. Elementary physics of vibrating systems. Propagation of sound: traveling waves, reflection, and diffraction. Addition of waves: interference and beats. Anatomy of the ear and the perception of sound: loudness, pitch, and timbre. Standing waves and natural modes. Qualitative description of general periodic systems by Fourier analysis: the harmonic series and complex musical tones. The acoustics of musical instruments including percussion instruments, such as drums, bars, and struck and plucked strings; and instruments exhibiting self-sustained oscillations, including bowed strings, blown pipes, reeds, brasses, and singing. Intervals and consonance, musical scales, tuning and temperament. Basic room and auditorium acoustics. There are no formal prerequisites, but an ability to read music and having some previous musical experience will be very useful.

33-115 Energy and Environmental Issues

Fall: 10 units

An introduction to the fundamental principles and methodology of physics. The course will introduce and use the physics concepts of energy and the laws of thermodynamics to analyze environmental issues, such as fossil fuel use, nuclear power, solar power and others. Issues of risk assessment will also be discussed. This course is intended for students in the Colleges of H&SS and Fine Arts and does not require calculus, however, students are expected to have some facility with basic algebra.

33-124 Introduction to Astronomy

Fall: 9 units

Astronomy continues to enjoy a golden age of exploration and discovery. This course presents a broad view of astronomy, straightforwardly descriptive and without any complex mathematics. The goal of the course is to encourage non-technical students to become scientifically literate and to appreciate new developments in the world of science, especially in the rapidly developing field of astronomy. Subjects covered include the solar system, stars, galaxies and the universe as a whole. The student should develop an appreciation of the ever-changing universe and our place within it. Computer laboratory exercises will be used to gain practical experience in astronomical techniques. In addition, small telescopes will be used to study the sky.

33-131 Matter and Interaction I

Fall: 12 units

A more challenging alternative to 33-111, Physics for Science Students I. Students with particularly strong physics backgrounds may volunteer for this course. Modeling of physical systems, including 3D computer modeling, with emphasis on atomic-level description and analysis of matter and its interactions. Momentum, numerical integration of Newton's laws, ball-and-spring model of solids, harmonic oscillator, energy, energy quantization, mass-energy equivalence, multiparticle systems, collisions, angular momentum including quantized angular momentum, kinetic theory of gases, statistical mechanics (temperature, entropy, and specific heat of the Einstein solid, Boltzmann factor). Corequisites: 21-120

33-132 Matter and Interactions II

Spring: 12 units

A more challenging alternative to 33-112, Physics for Science Students II. Emphasis on atomic-level description and analysis of matter and its electric and magnetic interactions. Coulomb's law, polarization, electric field, plasmas, field of charge distributions, microscopic analysis of resistor and capacitor circuits, potential, macroscopic analysis of circuits, Gauss' law, magnetic field, atomic model of magnetism, Ampere's law, magnetic force, relativistic

issues, magnetic induction with emphasis on non-Coulomb electric field, Maxwell's equations, electromagnetic radiation including its production and its effects on matter, re-radiation, interference. Computer modeling and visualization; desktop experiments.
Prerequisites: 21120 and 33131 Corequisites: 21-122

33-201 Physics Sophomore Colloquium I

Fall: 2 units

This course (together with 33-202) is designed to give students an overview of the field of Physics and to help students make knowledgeable choices in both their academic and professional careers. We discuss several of the sub-fields of Physics in order to give students an understanding of the types of activities, from research to industrial applications, in each. Over the two semesters, we typically discuss six subfields in some detail with the goal of providing a minimal literacy in the relevant concepts and language. The course consists of one classroom lecture per week plus one hour per week of reading and/or problem solving.

33-202 Physics Sophomore Colloquium II

Spring: 2 units

Continuation of 33-201.

33-211 Physics III: Modern Essentials

Fall and Spring: 10 units

Physics III is primarily for third-semester students of physics, including all physics majors, but is open to any qualified student who wants an introduction to the physics of the 20th century. The course will have a strong component of Special Relativity, dealing with kinematics and dynamics, but not electricity and magnetism. (See 33-213 description.) It will introduce students to a conceptual theory, which is mathematically simple but (initially) non-intuitive. The course also provides a broad exposure to quantum phenomena and early quantum theory without getting overly mathematical. It leads into the more formal Quantum Physics course.
Prerequisites: 33112 or 33132 or 33107

33-213 Mini-Course in Special Relativity

Fall and Spring: Mini Session - 4 units

This course spans the first six weeks of 33-211, Physics III: Modern Essentials. It treats the Mechanics aspects of Special Relativity, including topics such as simultaneity, the Lorentz transformation, time dilation, length contraction, space-time geometry, resolving some famous puzzles, and the momentum, mass, and energy relations. The Electricity and Magnetism portions of the subject are deferred until the junior/senior courses in E&M (33-338/33-339).
Prerequisites: 33112 or 33132 or 33107

33-224 Stars, Galaxies and the Universe

Fall: 9 units

The study of astronomy has blossomed over the past few decades as a result of new ground-based and space-based telescopes, and with the advantage of fast computers for analysis of the huge quantities of data. As our astronomical horizon expands, we are still able to use the laws of physics to make sense of it all. This course is for students who want to understand the basic concepts in astronomy and what drives astronomical objects and the universe. The course emphasizes the application of a few physical principles to a variety of astronomical settings, from stars to galaxies to the structure and evolution of the universe. Introductory classical physics is required, but modern physics will be introduced as needed in the course. The course is intended for science and engineering majors as well as students in other disciplines with good technical backgrounds. Computer lab exercises will be used to gain practical experience in astronomical techniques. In addition, small telescopes are available for personal sign-out for those who would like to use them, and outdoor observing sessions will be organized as weather permits.
Prerequisites: 33106 or 33111 or 33131

33-225 Quantum Physics and Structure of Matter

Fall: 9 units

This course introduces the basic theory used to describe the microscopic world of electrons, atoms, and photons. The duality between wave-like and particle-like phenomena is introduced along with the deBroglie relations which link them. We develop a wave description appropriate for quanta which are partially localized and discuss the interpretation of these wavefunctions. The wave equation of quantum mechanics is developed and applied to the hydrogen atom from which we extrapolate the structure of the Periodic Table. Other materials-related applications are developed, for example, Boltzmann and quantum statistics and properties of electrons in crystals. This course is intended primarily for non-physics majors who have not taken 33-211.
Prerequisites: 33107 or 33112 or 33132

33-228 Electronics I

Spring: 10 units

An introductory laboratory and lecture course with emphasis on elementary circuit analysis, design, and testing. We start by introducing basic circuit elements and study the responses of combinations to DC and AC excitations. We then take up transistors and learn about biasing and the behavior of amplifier circuits. The many uses of operational amplifiers are examined and analyzed; general features of feedback systems are introduced in this context. Complex functions are used to analyze all of the above linear systems. Finally, we examine and build some simple digital integrated circuits.

Prerequisites: 33107 or 33112 or 33132

33-231 Physical Analysis

Fall: 9 units

This course aims to develop analytical skills and mathematical modeling skills across a broad spectrum of physical phenomena, stressing analogies in behavior of a wide variety of systems. Specific topics include dimensional analysis and scaling in physical phenomena, exponential growth and decay, the harmonic oscillator with damping and driving forces, linear approximations of nonlinear systems, coupled oscillators, and wave motion. Necessary mathematical techniques, including differential equations, complex exponential functions, matrix algebra, and elementary Fourier series, are introduced as needed.
Prerequisites: 21122 and (33112 or 33132 or 33107)

33-232 Mathematical Methods of Physics

Spring: 9 units

This course introduces, in the context of physical systems, a variety of mathematical tools and techniques that will be needed for later courses in the physics curriculum. Topics will include, linear algebra, vector calculus with physical application, Fourier series and integrals, partial differential equations and boundary value problems. The techniques taught here are useful in more advanced courses such as Physical Mechanics, Electricity and Magnetism, and Advanced Quantum Physics.
Prerequisites: 33231

33-234 Quantum Physics

Spring: 10 units

An introduction to the fundamental principles and applications of quantum physics. A brief review of the experimental basis for quantization motivates the development of the Schrodinger wave equation. Several unbound and bound problems are treated in one dimension. The properties of angular momentum are developed and applied to central potentials in three dimensions. The one electron atom is then treated. Properties of collections of indistinguishable particles are developed allowing an understanding of the structure of the Periodic Table of elements. A variety of mathematical tools are introduced as needed.
Prerequisites: 33211

33-241 Introduction to Computational Physics

Fall: 9 units

The course emphasizes the formulation of physical problems for machine computation with exploration of alternative numerical methods. Work will be done on a range of computers from workstations to high performance computing platforms. Examples are drawn from Physics I and II, and Experimental Physics, as well as concurrent physics courses.
Prerequisites: 15100 and 21122 and 33104 and (33112 or 33132 or 33107)

33-301 Physics Upperclass Colloquium I

Fall: 1 units

Junior Physics majors meet together for 1 hour a week to hear discussions on current physics research from faculty, undergraduate and graduate students, and outside speakers. Other topics of interest such as application to graduate school, areas of industrial research and job opportunities are also presented.

33-302 Physics Upperclass Colloquium II

Spring: 1 units

Continuation of 33-301.

33-331 Physical Mechanics I

Fall: 10 units

Fundamental concepts of classical mechanics. Conservation laws, momentum, energy, angular momentum, Lagrange's and Hamilton's equations, motion under a central force, scattering, cross section, and systems of particles.

Prerequisites: 21259 and 33232

33-332 Physical Mechanics II

Spring: 10 units

This is the second semester of a two-semester course on classical mechanics. The course will use the tools developed in 33-331 to examine motion in non-inertial reference frames; in particular, rotating frames. This then leads to the development of general rigid body motion, Euler's Equations. Finally, the course will cover coupled oscillations with particular emphasis on normal modes.

Prerequisites: 33331

33-338 Intermediate Electricity and Magnetism I

Fall: 10 units

This course includes the basic concepts of electro- and magnetostatics. In electrostatics, topics include the electric field and potential for typical configurations, work and energy considerations, the method of images and solutions of Laplace's Equation, multipole expansions, and electrostatics in the presence of matter. In magnetostatics, the magnetic field and vector potential, magnetostatics in the presence of matter, properties of dia-, para- and ferromagnetic materials are developed.

Prerequisites: 21259 and 33232

33-339 Intermediate Electricity and Magnetism II

Spring: 10 units

This course focuses on electro- and magnetodynamics. Topics include Faraday's Law of induction, electromagnetic field momentum and energy, Maxwell's equations and electromagnetic waves including plane waves, waves in non-conducting and conducting media, reflection and refraction of waves, and guided waves. Electromagnetic radiation theory includes generation and characteristics of electric and magnetic dipole radiation. The Special Theory of Relativity is applied to electrodynamics: electric and magnetic fields in different reference frames, Lorentz transformations, four-vectors, invariants, and applications to particle mechanics.

Prerequisites: 33338

33-340 Modern Physics Laboratory

Spring: 10 units

Emphasis is on hands-on experience observing important physical phenomena in the lab, advancing the student's experimental skills, developing sophisticated data analysis techniques, writing thorough reports, and improving verbal communication through several oral progress reports given during the semester and a comprehensive oral report on one experiment. Students perform three experiments which are drawn from the areas of atomic, condensed matter, classical, and nuclear and particle physics. Those currently available are the following: Zeeman effect, light scattering, optical pumping, thermal lensing, Raman scattering, chaos, magnetic susceptibility, nuclear magnetic resonance, electron spin resonance, X-ray diffraction, Mössbauer effect, neutron activation of radioactive nuclides, Compton scattering, and cosmic ray muons.

Prerequisites: 33234 and (33331 or 33338 or 33341)

33-341 Thermal Physics I

Fall: 10 units

The three laws of classical thermodynamics, which deal with the existence of state functions for energy and entropy and the entropy at the absolute zero of temperature, are developed along phenomenological lines. Elementary statistical mechanics is then introduced via the canonical ensemble to understand the interpretation of entropy in terms of probability and to calculate some thermodynamic quantities from simple models. These laws are applied to deduce relationships among heat capacities and other measurable quantities and then are generalized to open systems and their various auxiliary thermodynamic potentials; transformations between potentials are developed. Criteria for equilibrium of multicomponent systems are developed and applied to phase transformations and chemical reactions. Models of solutions are obtained by using statistical mechanics and are applied to deduce simple phase diagrams for ideal and regular solutions. The concept of thermodynamic stability is then introduced and illustrated in the context of phase transformations.

Prerequisites: 33232 and 33234

33-342 Thermal Physics II

Spring: 10 units

This course begins with a more systematic development of formal probability theory, with emphasis on generating functions, probability density functions and asymptotic approximations. Examples are taken from games of chance, geometric probabilities and radioactive decay. The connections between the ensembles of statistical mechanics (microcanonical, canonical and grand canonical) with the various thermodynamic potentials is developed for single component and multicomponent systems. Fermi-Dirac and Bose-Einstein statistics are reviewed. These principles are then

applied to applications such as electronic specific heats, Einstein condensation, chemical reactions, phase transformations, mean field theories, binary phase diagrams, paramagnetism, ferromagnetism, defects, semiconductors and fluctuation phenomena.

Prerequisites: 33341

33-350 Undergraduate Research

Fall and Spring: 1-36 units

The student undertakes a project of interest under the supervision of a faculty member. May include research done in a research lab, extending the capabilities of a teaching lab, or a theoretical or computational physics project. The student experiences the less structured atmosphere of a research program where there is much room for independent initiative. A list of research projects is available. The student must contact a faculty member and/or the Assistant Head for the Undergraduate Affairs before registering so that student project pairings can be set. Reports on results are required at end of semester.

33-353 Intermediate Optics

Fall: 12 units

Geometrical optics: reflection and refraction, mirrors, prisms, lenses, apertures and stops, simple optical instruments, fiber optics. Scalar wave optics: wave properties of light, interference, coherence, interferometry, Huygens-Fresnel principle, Fraunhofer diffraction, resolution of optical instruments, Fourier optics, Fresnel diffraction. Laser beam optics: Gaussian beams. Vector wave optics: electromagnetic waves at dielectric interfaces, polarized light. The course will use complex exponential representations of electromagnetic waves.

Prerequisites: 33107 or 33112 or 33132

33-355 Nanoscience and Nanotechnology

Fall: 9 units

This course will explore the underlying science behind nanotechnology, the tools used to create and characterize nanostructures, and potential applications of such devices. Material will be presented on a level intended for upper-level science and engineering students. The course will start with a brief review of the physical principles of electric fields and forces, the nature of chemical bonds, the interaction of light with matter, and elastic deformation of solids. Characterization using electron microscopy, scanning probe methods, and spectroscopic techniques will then be described in detail. Fabrication using top-down and bottom-up methods will be discussed, contrasting these approaches and providing examples of each. Nanotechnology methods will be compared with those used in the modern micro-electronics industry. Finally, examples of nanoscale components and systems will be described, including quantum dots, self-assembled monolayers, molecular computing, and others. Stand-alone laboratory exercises will be included as an important element of the course. These will focus on the use of scanning probe methods to study the nm-scale structure and atomic forces involved in various nanostructures. Students will sign up for these laboratory sessions and perform the exercises under the supervision of a teaching assistant. In addition to the prerequisites, students should have taken a prior laboratory course in a science or engineering department and should have some familiarity with differential equations at an elementary level.

Prerequisites: 33107 or 33112 or 33132

33-441 Introduction to BioPhysics

Fall: 10 units

This intermediate level course is primarily offered to Physics and Biology undergrads (junior/senior) and provides a modern view of molecular and cellular biology as seen from the perspective of physics, and quantified through the analytical tools of physics. This course will not review experimental biophysical techniques (which are covered, e.g., in 03-871). Rather, physicists will learn what sets "bio" apart from the remainder of the Physics world and how the apparent dilemma that the existence of life represents to classical thermodynamics is reconciled. They also will learn the nomenclature used in molecular biology. In turn, biologists will obtain (a glimpse of) what quantitative tools can achieve beyond the mere collecting and archiving of facts in a universe of observations: By devising models, non-obvious quantitative predictions are derived which can be experimentally tested and may lead to threads that connect vastly different, apparently unrelated phenomena. One major goal is then to merge the two areas, physics and biology, in a unified perspective.

Prerequisites: 03121 and (33107 or 33112 or 33132)

33-444 Introduction to Nuclear and Particle Physics

Spring: 9 units

Description of our understanding of nuclei, elementary particles, and quarks, with equal emphasis on the nuclear and particle aspects

of sub-atomic matter. We discuss the physics of accelerators, and how particle interactions with matter lead to various kinds of detector instrumentation. Then we discuss methods for measuring sub-atomic structure, symmetries and conservation laws, and the electromagnetic, weak, and strong interactions. We examine the quark model of the mesons and baryons, as well as several models of the atomic nucleus.

Prerequisites: 33234 and 33338

33-445 Adv Quantum Physics I

Fall: 9 units

Mathematics of quantum theory, linear algebra and Hilbert spaces; review of classical mechanics; problems with classical mechanics; postulates of quantum theory; one dimensional applications; the harmonic oscillator; uncertainty relations; systems with N degrees of freedom, multi-particle states, identical particles; approximation methods.

Prerequisites: 33234 Corequisites: 33-331

33-446 Advanced Quantum Physics II

Spring: 9 units

Classical symmetries; quantum symmetries; rotations and angular momentum; spin; addition of angular momentum; the hydrogen atom; quantum "paradoxes" and Bell's theorem; applications.

Prerequisites: 33445

33-448 Introduction to Solid State Physics

Spring: 9 units

This course gives a quantitative description of crystal lattices, common crystal structures obtained by adding a basis of atoms to the lattice, and the definition and properties of the reciprocal lattice. Diffraction measurements are studied as tools to quantify crystal lattices, including Bragg's law and structure factors. Diffraction from amorphous substances and liquids is also introduced. The various types of atomic bonding, e.g., Van der Waals, metallic, ionic, covalent and hydrogen are surveyed. Binding energies of some crystalline structures are calculated. Models of crystal binding are generalized to include dynamics, first for classical lattice vibrations and then for quantized lattice vibrations known as phonons. These concepts are used to calculate the heat capacities of insulating crystals, to introduce the concept of density of states, and to discuss phonon scattering. The band theory of solids is developed, starting with the free electron model of a metal and culminating with the properties of conductors and semiconductors. Magnetic phenomena such as paramagnetism and the mean field theory of ferromagnetism are covered to the extent that time permits.

Prerequisites: (33234 or 33225) and 33341

33-451 Senior Research

Fall and Spring: 1-12 units

Open to all senior physics majors. May include research done in a research lab, extending the capabilities of a teaching lab, or a theoretical or computational physics project. The student experiences the less structured atmosphere of a research program where there is much room for independent initiative. Modern Physics Laboratory, 33-340, should precede this course, though it is not required. A list of research projects is available. The student must contact a faculty member and/or the Assistant Head for the Undergraduate Affairs before registering so that student project pairings can be set. Reports on results are required at end of semester.

33-456 Advanced Computational Physics

Spring: 9 units

This course emphasizes application of practical numerical techniques to the types of problems that are encountered by practicing physicists. The student will be expected to understand the principles behind numerical methods such as SVD decomposition, chi-squared minimization, and Fast Fourier Transforms and Monte Carlo simulation of experiments. Applications will include data analysis and eigenvalue problems. Emphasis will be placed on the ability to implement complex algorithms accurately by devising methods of checking results and debugging code. The students will be expected to become proficient in Fortran or C programming.

Prerequisites: 33241

33-458 Special Problems in Computational Physics

Fall and Spring: 9 units

The student will work under the direction of a Department faculty member on a computational physics problem of mutual interest.

Prerequisites: 33456

33-466 Extragalactic Astrophysics and Cosmology

Spring: 9 units

Starting from the expanding universe of galaxies, this course lays out the structure of the universe from the Local Group of galaxies

to the largest structures observed. The observational pinnacle of the Big Bang theory, the microwave background radiation, is shown to provide us with many clues to conditions in the early universe and to the parameters which control the expansion and fate of the universe. Current theories for the development of galaxies and clusters of galaxies are outlined in terms of our current understanding of dark matter. Observational cosmology continues to enjoy a golden era of discovery and the latest observational results will be interpreted in terms of the basic cosmological parameters.

Prerequisites: 33224 and 33234

33-467 Astrophysics of Stars and the Galaxy

Fall: 9 units

The physics of stars is introduced from first principles, leading from star formation to nuclear fusion to late stellar evolution and the end points of stars: white dwarfs, neutron stars and black holes. The theory of stellar structure and evolution is elegant and impressively powerful, bringing together all branches of physics to predict the life cycles of the stars. The basic physical processes in the interstellar medium will also be described, and the role of multi-wavelength astronomy will be used to illustrate our understanding of the structure of the Milky Way Galaxy, from the massive black hole at the center to the halo of dark matter which encompasses it.

Prerequisites: 33224 and 33234 Corequisites: 33-341

33-499 Supervised Reading

Fall and Spring: 1-12 units

The student explores a certain area of advanced physics under the supervision of a faculty member. The student must contact a faculty member and/or the Assistant Head for Undergraduate Affairs before registering.

33-650 General Relativity

Fall: 9 units

General Relativity (GR) is the foundation upon which we build a theory for the universe. The course will outline GR and provide the students with a solid physical understanding of the elegant theory. The course will also use GR to explain the observable universe and students will get an appreciation of this theory through modern-day experiments.

Prerequisites: 33211 and 33339

33-658 Quantum Computation and Quantum Information Theory

Spring: 9 units

This course provides an overview of quantum computation and quantum information theory. The topics include: an introduction to quantum mechanics; quantum channels, both ideal and noisy; quantum cryptography; an introduction to computational complexity; Shor's factorization algorithm; Grover's search algorithm; proposals for the physical realization of quantum devices, such as ions in traps, solid-state devices, and nuclear magnetic resonance. Linear algebra at the level of 21-241 or 21-341, or as taken up in 33-345, is a prerequisite; in addition, students who are not familiar with vector spaces over complex numbers, including unitary and Hermitian operators, will need to learn these topics on their own. Quantum mechanics is not a prerequisite, but some prior knowledge at the level of 33-234 or 33-445 will prove helpful. Algorithms and complexity theory are not prerequisites, but some prior knowledge at the level of 15-211, 15-251 or 15-451 will prove helpful. This course is also offered for 12 units as 33-758, which involves some additional work.

Statistics

36-201 Statistical Reasoning and Practice

All Semesters: 9 units

This course will introduce students to the basic concepts, logic, and issues involved in statistical reasoning, as well as basic statistical methods used to analyze data and evaluate studies. The major topics to be covered include methods for exploratory data analysis, an introduction to research methods, elementary probability, and methods for statistical inference. The objectives of this course are to help students develop a critical approach to the evaluation of study designs, data and results, and to develop skills in the application of basic statistical methods in empirical research. An important feature of the course will be the use of the computer to facilitate the understanding of important statistical ideas and for the implementation of data analysis. In addition to three lectures a week, students will attend a computer lab once a week. Examples will be drawn from areas of applications of particular interest to H&SS students. Not open to students who have received credit for 36-207/70-207, 36-220, 36-225, 36-625, or 36-247.

36-202 Statistical Methods

Spring: 9 units

This course builds on the principles and methods of statistical reasoning developed in 36-201 (or its equivalents). The course covers simple and multiple regression, analysis of variance methods, and logistic regression. Other topics may include non-parametric methods and probability models, as time permits. The objectives of this course is to develop the skills of applying the basic principles and methods that underlie statistical practice and empirical research. In addition to three lectures a week, students attend a computer lab once week for "hands-on" practice of the material covered in lecture. Not open to students who have received credit for: 36-208/70-208, 36-309, 88-250.

Prerequisites: 36201 or 36207 or 36220 or 36247 or 70207

36-207 Probability and Statistics for Business Applications

Fall: 9 units

This is the first half of a year long sequence in basic statistical methods that are used in business and management. Topics include exploratory and descriptive techniques, probability theory, statistical inference in simple settings, basic categorical analysis, and statistical methods for quality control. Not open to students who have received credit for 36-201, 36-220, 36-625, or 36-247. Cross-listed as 70-207.

Prerequisites: 21112 or 21116 or 21120 or 21121

36-208 Regression Analysis

Spring: 9 units

This is the second half of a year long sequence in basic statistical methods that are used in business and management. Topics include time series, regression and forecasting. In addition to two lectures a week, students will attend a computer lab once a week. Not open to students who have received credit for 36-202, 36-626. Cross-listed as 70-208.

Prerequisites: (21116 or 21120 or 21121 or 21112) AND (36207 or 70207 or 36201 or 36220 or 36247)

36-217 Probability Theory and Random Processes

All Semesters: 9 units

This course provides an introduction to probability theory. It is designed for students in electrical and computer engineering. Topics include elementary probability theory, conditional probability and independence, random variables, distribution functions, joint and conditional distributions, limit theorems, and an introduction to random processes. Some elementary ideas in spectral analysis and information theory will be given. The use of a computer package will be an integral part of this course (depending on the instructor). Not open to students who have received credit for 36-225, or 36-625.

Prerequisites: 21112 or 21122 or 21123 or 21256 or 21259

36-220 Engineering Statistics and Quality Control

All Semesters: 9 units

This is a course in introductory statistics for engineers with emphasis on modern product improvement techniques. Besides exploratory data analysis, basic probability, distribution theory and statistical inference, special topics include experimental design, regression, control charts and acceptance sampling. Not open to students who have received credit for 36-201, 36-207/70-207, 36-226, 36-626, or 36-247, except when AP credit is awarded for 36-201.

Prerequisites: 21116 or 21120 or 21121 or 21112

36-225 Introduction to Probability and Statistics I

Fall: 9 units

This course is the first half of a year long course which provides an introduction to probability and mathematical statistics for students in mathematics and statistics. The use of probability theory is illustrated with examples drawn from engineering, the sciences, and management. Topics include elementary probability theory, conditional probability and independence, random variables, distribution functions, joint and conditional distributions, law of large numbers, and the central limit theorem. Not open to students who have received credit for 36-217 or 36-625.

Prerequisites: 21112 or 21122 or 21123 or 21256 or 21259

36-226 Introduction to Probability and Statistics II

Spring: 9 units

This course is the second half of a year long course in probability and mathematical statistics. Topics include maximum likelihood estimation, confidence intervals, and hypothesis testing. If time permits there will also be a discussion of linear regression and the analysis of variance. Not open to students who have received credit for 36-626.

Prerequisites: 21325 or 36217 or 36225

36-247 Statistics for Lab Sciences

Spring: 9 units

This course is a single-semester comprehensive introduction to statistical analysis of data for students in biology and chemistry. Topics include exploratory data analysis, elements of computer programming for statistics, basic concepts of probability, statistical inference, and curve fitting. In addition to two lectures, students attend a computer lab each week. Not open to students who have received credit for 36-201, 36-207/70-207, 36-220, 36-226 or 36-626.

Prerequisites: 21116 or 21120 or 21121 or 21112

36-295 Independent Study

Fall and Spring: 0-36 units

Statistics majors are given the opportunity to conduct original research under the direction of a faculty member. Students are expected to propose a research topic, design and implement the study, analyze the data, and prepare a written report describing the investigation and results.

Prerequisites: 36201

36-303 Sampling, Survey and Society

Spring: 9 units

This course will revolve around the role of sampling and sample surveys in the context of U.S. society and its institutions. We will examine the evolution of survey taking in the United States in the context of its economic, social and political uses. This will eventually lead to discussions about the accuracy and relevance of survey responses, especially in light of various kinds of nonsampling error. Students will be required to design, implement and analyze a survey sample.

Prerequisites: 36202 or 36208 or 36226 or 36309 or 36625 or 70208 or 73260 or 73261 or 88250

36-309 Experimental Design for Behavioral and Social Sciences

Fall: 9 units

Statistical aspects of the design and analysis of planned experiments are studied in this course. A clear statement of the experimental factors will be emphasized. The design aspect will concentrate on choice of models, sample size and order of experimentation. The analysis phase will cover data collection and computation, especially analysis of variance and will stress the interpretation of results. In addition to a weekly lecture, students will attend a computer lab once a week. Not open to students who have received credit for 36-202.

Prerequisites: 36201 or 36207 or 36217 or 36220 or 36247

36-310 Fundamentals of Statistical Modeling

Fall and Spring: 9 units

This course provides a one-semester introduction to the theory of probability and mathematical statistics, suitable as background for more advanced 400-level statistics courses such as 36-401 and 36-402 (Modern Regression and Topics in Data Analysis). The course will emphasize probability models and distribution theory; the practice of statistical inference based on the use of maximum likelihood estimation; and applications of statistical modeling and inference, using case studies drawn from the social, physical and biomedical sciences. The use of a computer software package will be an integral part of this course.. Students who have taken 36225 or 36-625 may not receive credit for this course. Students who have taken 73-261 or 73-360 need permission of the instructor.

Prerequisites: (21112 or 21116 or 21121 or 21120) AND (36303 or 36309 or 36247 or 36208 or 36202 or 36220 or 88250)

36-315 Statistical Graphics and Visualization

Spring: 9 units

Graphical displays of quantitative information take on many forms as they help us understand both data and models. This course will serve to introduce the student to the most common forms of graphical displays and their uses and misuses. Students will learn both how to create these displays and how to understand them. As time permits the course will consider some more advanced graphical methods such as computer-generated animations. Each student will be required to engage in a project using graphical methods to understand data collected from a real scientific or engineering experiment. In addition to two weekly lectures there will be lab sessions where the students learn to use software to aid in the production of appropriate graphical displays.

Prerequisites: 36202 or 36208 or 36226 or 36303 or 36309 or 36625 or 88250

36-350 Data Mining

Fall: 9 units

The course will focus on how to construct hypotheses from a large data set and confirm them statistically. Exploratory methods

include discriminant analysis, principal component analysis, projection pursuit, clustering, and nonparametric density estimation. Confirmatory methods include confidence intervals, posterior distributions, and Bayes factors. In addition, student will learn how to think in terms of probabilistic models and use data mining software effectively. Some computer programming required.
Prerequisites: 36226 or 36310 or 36626

36-401 Modern Regression
Fall: 9 units

The material in this course concentrates on methods for the analysis of data. The emphasis is on description, validation, and interpretation. Topics include exploratory data analysis, statistical computing, and regression analysis. Real-world examples will be drawn from engineering and the various physical and social sciences. Students will do projects and write reports. Students who have taken 73-261 or 73-360 need permission of the instructor.
Prerequisites: 36226 or 36310 or 36626

36-402 Advanced Data Analysis
Spring: 9 units

This is a project course in data analysis. Students work in teams on a semester-long data analysis problem. Past projects have been drawn from current research in neuroscience, genetics, finance and psychology. Data analysis requires the application and extension of statistical methods and computing skills learned in 36-401. A key objective of the course is to expose students to the variety of challenges faced by the data analyst. Students research the scientific background of their problem, consult with subject-area scientists, and communicate their methods and results both in writing and in class presentations. At the end of the semester, each team presents a poster of their project at the "Meeting of the Minds" undergraduate research symposium.
Prerequisites: 36401

36-410 Introduction to Probability Modeling
Spring: 9 units

An introductory-level course in stochastic processes. Topics typically include Poisson processes, Markov chains, birth and death processes, random walks, recurrent events, and renewal theory. Examples are drawn from reliability theory, queuing theory, inventory theory, and various applications in the social and physical sciences.

Prerequisites: 21325 or 36217 or 36225 or 36625

36-461 Topics in Statistics
Fall: 9 units

The format and content of this course are flexible and vary from year to year depending on the instructor and demand. This semester's topic will be Statistical Methods in Actuary. The objective of the course is to expose students to important topics in statistics and/or interesting applications which are not part of the standard undergraduate curriculum.

Prerequisites: 36226 or 36310 or 36626

36-462 Topics in Statistics
Intermittent: 9 units

The format and content of this course are flexible and vary from year to year depending on the instructor and demand. Past topics included statistics and the law, Bayesian statistics, non-parametric statistics, decision theory, biostatistics, and time series analysis. The objective of the course is to expose students to important topics in statistics and/or interesting applications which are not part of the standard undergraduate curriculum.

Prerequisites: (36310 or 35401 or 36625 or 36626) AND (36217 or 36225 or 36226 or 36410 or 36625 or 36626)

36-625 Probability and Mathematical Statistics I
Fall: 12 units

This course is a fast-paced, rigorous introduction to the mathematical theory of probability, and statistical inference. It is ideal for students who want a crash-course in probability and mathematical statistics. A good working knowledge of calculus and basic linear algebra is required. Topics include sample spaces, probability, conditional probability, generating functions, sampling distributions, law of large numbers, the central limit theorem, maximum likelihood, the bootstrap, hypothesis testing, Bayesian inference, decision theory. Students studying Computer Science, or considering graduate work in Statistics or Operations Research, should carefully consider taking this course instead of 36-225 after consultation with their advisor. Not open to students who have received credit for 36-217 or 36-225.

Prerequisites: 21118 or 21122 or 21123 or 21256

36-626 Probability and Mathematical Statistics II

Spring: 12 units

A continuation of 36-625 emphasizing statistical models and methods. Topics include regression, multivariate models, causal inference, directed graphs, undirected graphs, curve estimation, classification, simulation. Students studying Computer Science should carefully consider taking this course instead of 36-226 after consultation with their advisor.

Prerequisites: 36625

MCS Interdisciplinary

38-101 Eureka

Fall and Spring: Mini Session - 3 units

Excited about science? Join your peers and faculty to explore science through this interdisciplinary laboratory course designed for first-year students. The course will bridge together laboratory experiences from biology, chemistry, and physics, with mathematics playing a central role in the data analysis of the experimental results. The experiments chosen for this course will illustrate the commonality of investigative techniques in these sciences and will emphasize experimental design and hypothesis testing. We will engage in weekly discussions not only on topics related to the laboratory experiments and projects in hand but also on some of the most exciting advances, deeper understanding, and ethical questions in science and mathematics.

38-709 Applied Cell and Molecular Biology

Fall: 12 units

This course will examine applications of modern cell and molecular biology, with emphasis on commercial products and processes. The course will include a basic background in the major topics that would be covered in courses on prokaryotic and eukaryotic molecular biology and molecular cell biology. The course is intended for non-specialists who seek an understanding and appreciation of fundamental concepts without the analysis of experimental detail that would support the development of concepts in a course for the specialist. The course will draw on the patent literature as a source of commercial applications of biological discoveries. Examples of the topics that might be included are: diagnostic and therapeutic monoclonal antibodies (e.g., Herceptin), therapeutic proteins (e.g., colony stimulating factors, erythropoietin, hormones), antibiotics, subunit molecular vaccines, amino acid fermentations, enzyme based processes for chemical synthesis, gene therapy, stem cells and regenerative medicine, herbicide tolerant plants, microbial diagnostics (e.g., multilocus sequence typing), transgenic animals, DNA fingerprinting.

38-710 Principles of Biotechnology

Spring: 12 units

This course is intended to provide an introduction to a set of core areas currently highlighted in the biotechnology industries. The objective is to provide the appropriate background for management level personnel to optimize their decision-making based on knowledgeable background in today's technologies. The focus will be on weekly modules of similar technologies with an introduction to technology/science behind the topic area and the applications of the technology in today's industries and markets.

CIT Interdisciplinary

39-100 Special Topics: WHAT IS ENGINEERING?

Fall: 9 units

What is Engineering? In today's world, we are so used to technology, helping us yet giving rise to complex problems, our friend and yet sometimes our challenge in preserving all that is human. This course is an introduction to all students about what engineers do and how they do it. It is about the culture, the thinking, the creativity and more than anything else, the doing which is at the heart of engineering. On a more pragmatic level, our world of ever-increasing technological complexity demands that everyone is to some extent familiar with things technical. William A. Wulf, President of the National Academy of Engineering, has said that a public that is technologically less than literate and unable to understand technical decisions is left to trust that good decisions will be made on their behalf. We invite you to take this course to get a feeling for what engineers experience in their work and bring out the creativity in each of you. The goal of this course is to help Carnegie Mellon students of all disciplines understand the role and impact of engineering in modern society and participate in the excitement of engineering. Demonstrations and hands-on projects will give students the experience of what engineers do. After completing this

course you will have a better understanding of the contributions of engineering to our society, how engineers see and think about the world, what the "big issues" for engineers are, what's involved in the different fields of engineering, and the tools engineers use. The multi-disciplinary and collaborative nature of almost all engineering work will be stressed. 39-100 is open to first through third year students in all majors except engineering.

39-200 Business for Engineers

Fall and Spring: 9 units

This course is intended to prepare CIT graduates for the fast paced world of modern industry. There have been paradigm shifts that complicate career selection and compound the difficulty of becoming a productive member of an organization. Graduates of a technical program can benefit from an understanding of modern business concepts when they begin their careers. The content of this course will include both specific financial analysis topics and certain business administration topics such as program management, entrepreneurship and ethics. Students will become familiar with analyzing financial statements, stock market reports and stock options while developing their verbal and written presentation skills.

39-245 Rapid Prototype Design

All Semesters: 9 units

This course provides an introduction to rapid design through virtual and physical prototyping. The class covers the engineering design process, problem solving methods, interdisciplinary team work, current industrial practice, and manufacturing process capabilities. The course emphasizes hands on learning. Sophomores have priority while registering for this course. Juniors and seniors will be put on the waitlist, then released once sophomores have registered.

39-250 CIT Undergraduate Projects

Fall: 0-18 units

This course number is to be used for Fall CIT freshman research projects only. Student must complete a CIT Undergraduate Project Approval form (located in Scaife Hall 110) and submit for approval. The form must include a complete description and a signature approval from the research advisor/instructor. If the project is approved, the CIT Undergraduate Studies Office will add the course to the student's fall schedule.

39-251 CIT Undergraduate Projects

Spring: 0-18 units

This course number is to be used for Spring CIT freshman research projects only. Student must complete a CIT Undergraduate Project Approval form (located in Scaife Hall 110) and submit for approval. The form must include a complete description and a signature approval from the research advisor/instructor. If the project is approved, the CIT Undergraduate Studies Office will add the course to the student's fall schedule.

39-447 CIT Undergraduate Interdisciplinary Design Project

All Semesters: 3-24 units

This course is to be used for undergraduate research projects involving a significant interdisciplinary design component. It can be added by permission only through collaboration with the student, project advisor, and the CIT Dean's Office. For projects that are not interdisciplinary in nature, students should refer to the research number specific to the department in which the research is being completed.

39-499 Summer Curricular Practical Training

Summer: 3 units

The college of engineering at Carnegie Mellon considers experiential learning opportunities important educational options for its undergraduate students. One such option is an internship, normally completed during the summer. Students do not need to officially register for an internship unless they want it listed on their official transcripts. CIT students interested in registering their internship for course credit on their transcript may enroll in this course. To do so, students must complete a CIT Internship form (located in Scaife Hall 110) and submit for approval. The CIT Undergraduate Studies Office will add the course to the student's schedule, and the student will be assessed tuition for 3 units. Upon completion of the internship, students must submit a 1-2 page report of their work experience, and a 1-2 page evaluation from the company supervisor to the CIT Undergraduate Office. After the reports has been reviewed and approved, a "P" grade will be assigned. This process should be used by international students interested in Curricular Practical Training (CPT) or by any other engineering undergraduate wishing to have their internship experience reflected on their official University transcript. International students should also be authorized by the Office of International Education (OIE). More information regarding CPT is available on OIE's website.

39-500 Honors Research Project

All Semesters: 1-36 units

Juniors who have an accumulated QPA of at least 3.5 receive an invitation to participate in the program. This course, open by invitation only, will provide the opportunity for close interaction with a faculty member through independent honors research in a number of disciplinary and interdisciplinary areas, as part of the CIT Honors Research Program. Students will work on their projects during their senior year, earning the equivalent of 18-24 units. Students are required to register for CIT Honor Research Project 39-500. To receive CIT College Honors, a student must complete at least 18 units in 39-500 on the same research topic. Students are also required to participate in the CIT poster competition at the Undergraduate Research Symposium, "Meeting of the Minds," a university-wide celebration of undergraduate research.

39-600 Integrated Product Development

Fall: 12 units

The IPD course focuses on team-based integrated product development among engineering, business, and design disciplines. The course is open to seniors and graduate students in engineering, industrial and communication design, and MBA students. The course generally has about a dozen students from each discipline. The course consists of four modules including identifying, understanding, conceptualizing and introducing a product opportunity. In recent years we have partnered with industrial sponsors to address a customer opportunity, resulting in patent applications. The emphasis in the course is on the early, "fuzzy" stage of product development. The course gives structure to these stages and helps direct the process to be more efficient downstream. Students are expected to produce four phase written and oral reports. At the end of the semester the team will develop a form prototype, function prototype, marketing plan and manufacturing plan for the product. This course has gained an international reputation as a leading course in new product development. Course admission by permission of professor only; all students will be waitlisted until admission decisions are made. Students should contact the professor for an application for the course.

39-605 Engineering Design Projects

Fall: 12 units

In this project course, students work in multidisciplinary teams to design products or processes. The course is open to juniors, seniors and graduate students from all parts of the campus community. Each project is sponsored by an industry, government or non-profit partner, and is of real commercial interest to that partner. Students work directly with their partner throughout the semester to establish goals and requirements, evaluate their design as it progresses, and produce a final report, presentation, and, if appropriate, a prototype. Design reviews, held twice during the semester, give students a chance to present their preliminary designs and receive feedback and advice. In completing their designs, teams must consider not only the functionality of their designs, but also the look, feel, appearance, and societal impact. Skills built in this course will include: developing the product statement, establishing goals and constraints for the product, project management, and generating and evaluating design alternatives. As some projects may span multiple semesters with new groups of students, careful documentation of project work is emphasized. Students may take this course for either one or two semesters.

39-606 Engineering Design Projects

Spring: 12 units

In this project course, students work in multidisciplinary teams to design products or processes. The course is open to juniors, seniors and graduate students from all parts of the campus community. Each project is sponsored by an industry, government or non-profit partner, and is of real commercial interest to that partner. Students work directly with their partner throughout the semester to establish goals and requirements, evaluate their design as it progresses, and produce a final report, presentation, and, if appropriate, a prototype. Design reviews, held twice during the semester, give students a chance to present their preliminary designs and receive feedback and advice. In completing their designs, teams must consider not only the functionality of their designs, but also the look, feel, appearance, and societal impact. Skills built in this course will include: developing the product statement, establishing goals and constraints for the product, project management, and generating and evaluating design alternatives. As some projects may span multiple semesters with new groups of students, careful documentation of project work is emphasized. Students may take this course for either one or two semesters.

39-648 Rapid Design and Prototyping of Computer Science
Spring: 12 units

This course deals with rapid prototyping, manufacture, and applications of a new generation of wearable computers, with head-mounted display. The design of wearable computers is a multidisciplinary process including: Electronic design, mechanical design, software development, and human-computer interaction. Two classes of wearable computers will be further developed: embedded, custom designed VuMan series, and general purpose Navigator series. Electronic design includes the custom designed computer board, electronic interfacing, and power supply. Industrial designers and mechanical engineers team to design and manufacture with in-house facilities a variety of conformable/lightweight housings. A software development environment and user interface builders support software and application development. Current applications include: Global Position Sensing, Hypertext documents, speech recognition, wireless communications, and digital imaging.

Biomedical Engineering

42-101 Introduction to Biomedical Engineering
Fall and Spring: 12 units

This course will provide exposure to basic biology and engineering problems associated with living systems and health care delivery. Examples will be used to illustrate how basic concepts and tools of science & engineering can be brought to bear in understanding, mimicking and utilizing biological processes. The course will focus on four areas: biotechnology, biomechanics, biomaterials and tissue engineering and bioimaging and will introduce the basic life sciences and engineering concepts associated with these topics. Pre-requisite OR co-requisite: 03-121 Modern Biology.
Prerequisites: Corequisites: 03-121

42-200 Sophomore BME Research Project
Fall and Spring: 3-12 units

Research projects for sophomores under the direction of a regular or courtesy BME faculty member. Arrangements may also be made via the Associate Head of BME for off-campus projects at local hospitals provided that a regular or courtesy BME faculty member agrees to serve as a co-advisor. The nature of the project, the number of units, and the criteria for grading are to be determined between the student and the research advisor. The agreement should be summarized in a one-page project description with sign-off by the research advisor and a copy submitted for review and filing to the student's academic advisor. A final written report or oral presentation of the results is required. Units may vary from 3 to 12 according to the expected time commitment.

42-201 Professional Issues in Biomedical Engineering
Fall and Spring: 3 units

This course helps students learn to understand technical and professional challenges biomedical engineers face. First, it introduces students to applications of technology in medicine and biology. Second, it provides an overview of professional topics involving bioethics, regulatory issues, communication skills, team work, and contemporary issues. Outside speakers describe real world problems and professional issues in biotechnology and bioengineering, and progress toward their solution. Students have the opportunity to visit state-of-the-art laboratories in such areas as bioimaging, musculoskeletal biomechanics, rapid prototyping and manufacturing, and cardiac assist devices. Prerequisite or co-requisite: 42-101 Introduction to Biomedical Engineering
Prerequisites: 42101

Architecture

48-095 Architecture for Non-Majors I
Fall and Spring: 9 units

This course serves as an introduction to the spatial concepts of architecture for students from other disciplines. The course is focused entirely on project design work (this is not an historical survey, technical or lecture course). Projects will explore the design and experience of spatial environments through a series of creative investigations. The first half of the semester will focus on short projects, with each design investigation progressively building upon the previous exploration; these early projects will consist of both individual and group work. The second half of the semester will consist of one long term project to be created individually, incorporating students' personal theories of architecture. Studio work will be supported by group discussion based upon critical review of student work, readings, slide presentations, videos and films. Students are encouraged to explore their own areas

of interest with respect to their work in class. Self-motivation, class attendance and an open mind is mandatory, however, no prior architectural, engineering or artistic experience is required. Students are expected to perform work both inside and outside of class. Students should be prepared to purchase various supplies throughout the course. This course is in partial fulfillment of requirements for an Architecture Minor.

48-100 Architecture Design Studio: Form
Fall: 12 units

This is the first course in the design studio sequence. As such, it establishes the foundation of exploration into the design process and provides the fundamental abilities required to represent the students' inductive and deductive ideas as it pertains to spatial thinking. The semester is divided into two halves: The first half of the semester is devoted to teaching fundamental skills which involve collaboration, experimentation, working at full size, testing, ecological research and basic architectural fundamentals such as drawing and making as they pertain to small scale design projects. These projects focus on teaching fundamentals such as point, line, plane and volume as well as fundamental drawing skills such as line types, plan, section, elevation, volumetric and analytical drawing. The design process then shifts to projects, which introduce the student to spatial thinking. Students are asked to explore the fundamental issues of space through geometry, spatial definition, spatial transparency, overlap and articulation. These projects are explored in both the studio setting as well as through a woodshop project. By the end of the semester students are given an elementary program, which is to adapt the students' spatial strategy to a specific landscape environment. By developing a relationship between the spatial enclosure, landscape, and the natural environment, the student is to show a basic understanding in spatial thinking through graphic, mock-up, physical and digital modeling.

48-105 Architecture Design Studio: Space
Spring: 12 units

The spring semester, Methods and Transformations in Space of the first year architecture program extends from experiences in the fall semester Methods and Transformations in Form. Architecture as a spatial practice is introduced. Design projects evolve from previous studies of structure surface and volume in plant and landscape paradigms. Systems and sequences previously explored in nature are developed in cultural contexts through a progressive series of projects. Mapping human behavior and studying architectural precedents create spatial temporal experiences and narratives. Architectural and interdisciplinary analyses launch each project as a vehicle for generative design strategies. Fluid connections between drawing (freehand and drafted) and modeling (physical, computer, and wood shop) are continued. The semester is divided into three primary design projects: WOODSHOP: The studios explicit relationship to the woodshop is expanded in this course. ROOM (Private) INTERIOR: This project introduces a group research project of architectural precedents as its analytical catalyst. The study of an interior space focuses the transition from form to that of space. PLACE (Public) BUILDING: This project uses, interdisciplinary, cultural research as its analytical formal catalyst. The study of a public infill building establishes architecture within an urban context and requires ability to create spatial sequences of public / private programmatic function. The process includes freehand drawing, model building, shade and shadow, digital modeling, and drafting.
Prerequisites: 48100

48-115 Physics for Architects
Spring: 9 units

Physics is a basic science, typically taught by the College of Science. Physics for Architecture was introduced in Spring, 2005 to best address the academic needs of students in the School of Architecture. It is taught as a science course that provides an emphasis on the physics topics most essential to architecture. The course covers units, vectors, motion in 2D and 3D, Newton's Laws of Motion, Applying Newton's Laws, work, energy, conservation of energy, momentum, impulse, collisions, rotation, equilibrium, gravitation, periodic motion, fluids, temperature, heat, thermal properties, and the first law of thermodynamics. The course is very similar to those offered by the physics department, but it is modified to place heavier emphasis on those topics pertinent to architecture, specifically: forces, reactions, equilibrium, dynamics, vibration, thermal properties of matter, heat transfer, and insulation.
Prerequisites: 21114 or 21120

48-120 Introduction to Digital Media I
Fall: 9 units

IDM is a required course for all first year architecture students. The course introduces students to a wide range of digital methods and concepts available to architects for design, representation, and

documentation. The coursework is directly coordinated with Studio assignments providing the students with the opportunity to master their digital skills in a meaningful manner. Due to the amount of content covered there is no single text for this course, but the course is supported by materials created by the instructor. IDM addresses topics such as digital image editing, vector illustration, HTML coding, and 3D modeling.

48-125 Introduction to Digital Media II

Spring: 6 units

IDM2 is a required course for all first year architecture students. This course is the continuation of IDM. IDM2 introduces students to measured drafting and the process of creating a construction drawing set. The coursework is directly coordinated with Studio assignments providing the students with the opportunity to master their digital skills in a meaningful manner. Due to the amount of content covered there is no single text for this course, but the course is supported by materials created by the instructor. IDM2 addresses topics such as digital drafting, construction drawings, advanced 3D modeling and HTML programming.

Prerequisites: 48120

48-130 Architectural Drawing I: A Tactile Foundation

Fall: 6 units

Architectural Drawing I: A Tactile Foundation is the introductory course in a sequence of three drawing courses required by the school of architecture for its professional degree program. It consists of exercises in free-hand perspective, orthographic drawing, and general life-drawing. Part 1 focuses on volume, Part 2 on contour, and Part 3 on mass: a structure that parallels, in some respects, the on-going work in 48-100. Topics are introduced through figure drawing and lecture demonstrations and subsequently applied to architectural subjects. The approach of each part is based on the work of Kimon Nicolaidis as presented in his landmark book, the *Natural Way to Draw*. Part 3 provides a review of earlier work as well as two joint projects with the design studio 48-100.

48-132 Architectural Drawing I: A Tactile Foundation (for non-architecture majors)

Fall: 9 units

Architectural Drawing I: A Tactile Foundation is the introductory course in a sequence of three drawing courses required by the school of architecture for its professional degree program. It consists of exercises in free-hand perspective, orthographic drawing, and general life-drawing. Part 1 focuses on volume, Part 2 on contour, and Part 3 on mass: a structure that parallels, in some respects, the on-going work in 48-100. Topics are introduced through figure drawing and lecture demonstrations and subsequently applied to architectural subjects. The approach of each part is based on the work of Kimon Nicolaidis as presented in his landmark book, the *Natural Way to Draw*. Part 3 provides a review of earlier work as well as two joint projects with the design studio 48-100. This course is open to other disciplines.

48-135 Architectural Drawing II: Appearance

Spring: 9 units

Architectural Drawing II: Understanding Appearance aims at building students' understanding of projective geometry, understanding of the appearance of architecture and its' representation in light and color. Part 1 focuses on free-hand and constructed linear perspective, Part 2 on shade, and shadow construction and chiaroscuro drawing, and Part 3 on pastel color drawing. Topics are introduced through lecture demonstrations and in-class exercises with subsequent application to architectural subjects. Parts 2 and 3 include joint studio assignments with 48-105.

Prerequisites: 48130

48-137 Architectural Drawing II: Appearance

Spring: 6 units

Architectural Drawing II: Understanding Appearance aims at building students' understanding of projective geometry, understanding of the appearance of architecture and its' representation in light and color. Part 1 focuses on free-hand and constructed linear perspective, Part 2 on shade, and shadow construction and chiaroscuro drawing, and Part 3 on pastel color drawing. Topics are introduced through lecture demonstrations and in-class exercises with subsequent application to architectural subjects. Parts 2 and 3 include joint studio assignments with 48-105.

Prerequisites: 48130 or 48132

48-200 Architecture Design Studio: Composition

Fall: 18 units

This studio is an introduction to architectural design stressing concept generation and the development of a rich design process to create evocative spatial experiences through architecture.

Building on the explorations of form and space in the 1st year, we investigate in greater depth the role that program, context, and the physical "elements of architecture" play in creating meaningful architecture. We seek to understand design principles underlying the buildings of the past and present, from the broadly theoretical and conceptual, to the real implications of tectonics and sustainability, and apply these ideas with intent and significance. We will focus on developing challenging architectural ideas, profound building details, and effective ways of communicating them in order to explore architecture's potential for creating poetic expressions, appropriate shelter, or exalted experiences, as well as its ability to embody ideas and impart meaning to the world around us.

Prerequisites: 48105

48-205 Architecture Design Studio: Materials

Spring: 18 units

Building on the fall studio, the spring semester is concerned with more in-depth understanding and development of designs for small-scale buildings, now informed by greater knowledge related to materials, fabrication, and the act of construction. Following the "New Materiality" evident in architecture today, and acknowledging the importance of materials and assembly techniques for sustainable design, we seek to explore the aesthetic and experiential meaning of materials (WHY?), and the technical knowledge related to the use of materials and the processes of construction (HOW?). The creative opportunities and design implications of using varied materials, structural systems, fabrication and assembly techniques--both analogue and digital--are elaborated, especially as they determine the artistic, conceptual, poetic, creative, spatial, and experiential aspects of architecture. The studio projects, lectures, and the required building study will focus on the application and integration of knowledge acquired in a parallel "Materials & Assembly" course 48-215.

Prerequisites: 48200 and 48210 Corequisites: 48-215

48-210 Statics

Fall: 9 units

Statics is a required course taught in the second year. Its prerequisites are calculus and physics. Statics is a prerequisite for structures courses. The course covers vector mechanics; forces and moments; equilibrium of rigid bodies; reactions; sections and internal forces on free-bodies; analysis of simple beams and trusses; stress and strain; elasticity; bending stress; shear stress; beam design.

Prerequisites: (21114 or 21120) AND (48115 or 33106)

48-215 Materials and Assembly

Spring: 9 units

The fourth semester of architectural studies at Carnegie Mellon University is concerned with the detailed development and refinement of architectural design as informed by the meaning, aesthetics and techniques related to the usage of materials and the process of construction. This is the fourth lecture course of the technology sequence and focuses on the principles of building construction utilizing contemporary systems. Materials and Assembly, taught in parallel with the design studio and Structures I, allows in - depth exploration of the fundamentals of contemporary construction, while the studio provides a simultaneous setting for the application and synthesis of this knowledge. The materials science content of the course examines construction materials with regard to their process of manufacture, their physical properties, their environmental performance and their methods of selection and specification. The assembly content of this course examines the selection, design, preliminary sizing and methodology of construction systems in wood, masonry, steel, sitecast concrete and precast concrete. The class introduces the fundamentals of enclosure systems.

Prerequisites: 12235 or 48210

48-217 Structures

Spring: 9 units

Structures is a required course taught in the second year. It is a successor course to Statics, complementing that previous course by emphasizing structural member design in wood, steel, and reinforced concrete; spatial synthesis of hierarchical one-way systems for gravity load; structural types for lateral load including braced frames, shear walls, and rigid frames; introduction to geometric structures such as cable nets, domes, shells, and air-supported structures.

Prerequisites: 12207 or 48210

48-230 Architectural Drawing III: Perspective

Fall: 9 units

Architectural Drawing III: Perspective emphasizes free-hand perspective skill and its' use as a design tool. Following a brief

review of perspective construction from orthographic views at the outset, the course addresses perspective on the basis of three distinct understandings of perceptual psychology. In sequence, these are: 1) A Kinesthetic Basis for Perspective: This work is built on the drawing pedagogy of Kimon Nicolaides. It aligns with the transactionalist understanding of perception, and it considers perspective as partly invented and partly discovered truth. 2) The Order of Appearance: This work is built on the early work of the perceptual psychologist, J.J. Gibson, and aligns with the ecological position of Gibson and his followers. It considers perspective as an absolute truth of the visual field. 3) Perspective Imposed: This work aligns implicitly with the position of Gestalt psychology. It treats perspective as an imposed schema. Each of these three sequences is introduced in lecture and developed through in-class exercises. Prerequisites: 48105 or 48135

48-232 Architectural Drawing III: Perspective (for Drama students)
Fall: 6 units

Architectural Drawing III: Perspective emphasizes free-hand perspective skill and its use as a design tool. Following a brief review of perspective construction from orthographic views at the outset, the course addresses perspective on the basis of three distinct understandings of perceptual psychology. In sequence, these are: 1) A Kinesthetic Basis for Perspective: This work is built on the drawing pedagogy of Kimon Nicolaides. It aligns with the transactionalist understanding of perception, and it considers perspective as partly invented and partly discovered truth. 2) The Order of Appearance: This work is built on the early work of the perceptual psychologist, J.J. Gibson, and aligns with the ecological position of Gibson and his followers. It considers perspective as an absolute truth of the visual field. 3) Perspective Imposed: This work aligns implicitly with the position of Gestalt psychology. It treats perspective as an imposed schema. Each of these three sequences is introduced in lecture and developed through in-class exercises. Prerequisites: 48135 and 48137

48-240 Historical Survey of World Architecture and Urbanism
Fall: 9 units

Reflecting the inseparable relation between building and human needs, this lecture course is not only a history of architecture, but also a history through architecture. This course examines architectural and urban design as a form of cultural expression unique to its time and place. The design, use, meaning and legacy of a building is conditioned not only by the architect's will or the patron's desire, but also by a web of technological, religious, social, cultural, economic, and political factors of the time. This course cuts a broad swath through time, geography and cultures, surveying critical episodes in the built environment of Europe, the Middle East, Asia, and the Americas from ancient to present times. This foundation course is the first in the architectural history sequence, and introduces students to the subject and skills of world architectural history. It is a prerequisite for all subsequent architectural history courses. Prerequisites: 64100 or 79104

48-300 Architecture Design Studio: Site
Fall: 18 units

Design Studio III: Building and Site is a required course taught in the third year. The subjects of the Third Year Fall Semester are the reciprocal orders of buildings and landscapes and the development of the building site. The work builds on knowledge gained in prerequisite and co-requisite courses including 48-312 Site Engineering. This course asks students to continue their investigations into the formal and spatial composition and enquiries of previous semesters with a focus on the following concepts: Occupancy: Social and cultural phenomena, dimension/ measurement and cycles of time relating to human and non-human occupancy Site assessment: site inventory at many scales Grading and surface manipulation: compatibility of grading with related technical considerations for water management, ground structures, surfacing, plants, and maintenance Road alignment: design of roads and parking to support construction, service and the anticipated occupancies, design of roads to connect to other roads with appropriate sight lines, stack spaces, and turning requirements, layout and sizing of parking spaces for vehicles Stormwater: volume and direction of runoff water on both the undisturbed and developed areas, storm water surface system, Plants: selection of plants and plant communities with consideration for regional, local, and site-specific factors Prerequisites: 48205 and 48217

48-305 Architecture Design Studio: Advanced Construction
Spring: 18 units

The basis for the CMU studio course sequence is the expectation that the student retains and applies knowledge gained each

semester to the current studio. The spring semester of the third year of architectural studies at Carnegie Mellon University is concerned with the detailed development and refinement of an architectural design as informed by the technical knowledge of structural systems, enclosure systems and the process of construction. The student is expected to articulate concepts and develop designs with more precision and in greater detail than done in previous studios and courses. In addition to criteria related to the development of design skills appropriate to one's sixth semester of the studio sequence, the following criteria are an explicit part of the evaluation of the student work: Aesthetics: The degree to which the design responds to formal issues as articulated in prior design studios. Structural System: The degree to which the proposed building is presented as a statically stable structure which defines the spatial order and satisfies the architectural intentions made explicit in the project. Enclosure System: The degree to which the proposed enclosure system satisfies the design requirements and responds to the physical phenomena of the environment into which it is placed. Material Selection: The degree to which the selected building materials and their implementation are appropriate to the occupancy, articulate the architectural order, and satisfy the physical design requirements. Constructability: The degree to which the proposed building is developed in response to an understanding of the processes of construction. Presentation: The clarity, craft and completeness of the presentation. Prerequisites: 48300 and 48312

48-312 Site Engineering and Foundations

Fall: 6 units

Site Engineering and Foundations is a required course taught in the third year. It is a companion course to the Site Studio (48-300) and covers materials related to the issues of surface and its manipulation (grading, road alignment and stormwater), soils (fundamentals of soil mechanics) and structures (fundamentals of foundation design). Students are introduced to the conceptual fundamentals, exposed to applications in the field, and develop skills which are demonstrated in this class and in their studio work. The course syllabus is broader than found in any existing text treatment, but is supported by one required textbook, two recommended texts and excerpts from other sources. Prerequisites: 48217

48-315 Environment I: Climate & Energy

Fall: 9 units

Environmental Systems is a required course taught in the third year. This course introduces architectural design responses for energy conservation, human comfort, and the site-specific dynamics of climate. Students are expected to combine an understanding of the basic laws of comfort and heat flow with the variables of local climate to create regionally appropriate energy design guidelines for their design projects. The state of the art in building energy conservation and passive heating and cooling technologies, as well as the emerging field of sustainable design are presented, with take-home readings and assignments. To stress the significance of architectural design decision making on energy consumption and comfort, full design specifications and hand calculations are completed individually by each student for a residential-scale building. Students compile a professional energy consultant's report, designing the most viable energy conservation retrofit measures for their client from: siting, massing, organization, enclosure detailing, opening control, to passive system integration and management. An overview of world energy consumption in buildings and energy design standards is challenged by lectures on building energy conservation successes and competitive challenges of sustainability. The course ends with a focus on the design integration of natural conditioning systems and the potentially dynamic interface of mechanical systems in small- and large-scale buildings. Prerequisites: 33106 or 48115

48-340 Modern Architecture and Theory 1900-1945

Intermittent: 9 units

This architectural history lecture course surveys the modern buildings and literature of the first half of the twentieth century, focusing primarily on Europe but extending also to non-western countries. We begin with a look at the "crisis of modernity" that plagued most of western civilization in the late 19th-century, and then focus on the major movements of both the avant-garde and other responses to modernity from 1900-1945. The course includes lectures, readings, and discussions about a broad range of issues and how they affected the conception, design, building, and reception of modern architecture, including 1) Formal tendencies; 2) Theoretical issues; 3) National traditions; 4) Biographical sketches; 5) Significant technologies and materials; 6) Political motivations; 6) Social & cultural influences. Emphasis will be placed on the relationship of buildings to the more general cultural, intellectual,

and historical circumstances in which they were created. Special attention will be devoted throughout the course to the important manifestoes, theoretical and critical writings that so determined the project of modern architecture. Work for the course involves extensive reading and a major research paper. .
Prerequisites: 48240

48-341 History of Architectural Theory Intermittent: 9 units

Architecture is not only building, technology, drawings, etc., but also discourse, meaning, communication, and concept: or theory. This architectural history seminar will study in roughly chronological order some of the major theories and theoreticians of architecture, from Vitruvius, through the Renaissance, the Enlightenment, the 19th-century, up to the modern era. Throughout the seminar we will chart the changing definitions of what constitutes "theory" in architecture, and how it relates to other writings such as criticism and history. We'll study in-depth how (if at all) the individual theory relates to the intellectual context and built works before and after, and begin to identify such as . Students will discover how ideas reoccur, and even the oldest theories have contemporary relevance. The seminar will culminate with presentations by students on post-war (1945-75) theories of architecture. Work for the seminar will involve extensive readings, active class discussions, and a "report" on post-war theory.
Prerequisites: 48240

48-343 American Built Environment Since 1860 Intermittent: 9 units

This course examines the built environment of the U.S. from the mid-nineteenth through the mid-twentieth centuries. That period of dramatic urban growth, suburban invention, and architectural exploration created an architectural and cultural landscape that is with us today. This course examines that century of building by continually asking "what were they thinking?" and exploring the built environment's relationship to the social, political, and economic conditions of its time and place. We will be looking at both canonical and non-canonical examples of American architecture, and will use Pittsburgh as a touchstone for understanding broader national trends in American architectural and urban design.
Prerequisites: 48240

48-344 Architecture of Henry Hornbostel Intermittent: 9 units

This course addresses the architectural career of Henry Hornbostel (1867-1961) from the beginning of his architectural education at Columbia University in the late 1880s through his retirement from the profession in 1939 until the revival of interest in his work in the 1980s. Hornbostel studied at the Ecole des Beaux-Arts in Paris, which is reflected in his early work. Later designs incorporate the abstracting tendencies of the Streamline Moderne or Art Deco. Throughout his career, Hornbostel was consistently innovative, eclectic and not necessarily easy to classify, even though the Beaux-Arts label provides an easy way to pigeon-hole (some of) his work. Interest in Hornbostel often begins with his buildings on campus. Many consider the CFA building Hornbostel's masterpiece. Nearby, Hornbostel designed the Rodef Shalom Synagogue, the Soldiers' and Sailors' Memorial, the Schenley Apartments, Webster Hall and a number of buildings for the University of Pittsburgh in Oakland alone. Downtown, the City County Building, the Grant Building and the German Evangelical Protestant (now Smithfield United) Church are also prominent elements in his corpus. Not simply a "Pittsburgh architect," Hornbostel enjoyed national prominence in the profession during his career. He consistently won design competitions for prestigious commissions throughout the country in New York, Ohio, West Virginia, Georgia, Illinois and California. Hornbostel died in 1961, Modernism's heyday, so he was largely forgotten. There is only a single monograph on Hornbostel and a comparatively small bibliography of recent publications. The exciting counterbalance to this dearth of secondary literature is the presence of many nearby significant built works and major archives of original drawings and other documents at CMU. These play a role in the course.
Prerequisites: 48240

48-345 The Cultural Landscape of Northern Italy: Land, City, Architecture

All Semesters: 9 units
The course proposes to plunge into the richness of the cultural landscape of Northern Italy, to examine through its architecture and its culture the relationship of man with land over time. The layers of different cultural and artistic traditions, superimposed and entwined by the passing of time and the changing of rulers and governments, will be read in the frame of a geographic area that is a work of art as well as a powerful narrative of history and culture. In the historical context of the early modern and modern history

of the area, the course will deal as well with some urban case studies: the main focus will be the city of Venice, with its rich and complex history, its peculiar blend of cultural and artistic influences and its power to fascinate and inspire through the centuries artists and craftsman, intellectuals and scholars. As if we were traveling through the region, we will start from the cities and territory that we see today, to learn to unearth the layers of their history, their geographic, economical and cultural connections, and to understand the challenge underlying the need to select and preserve part of this incredibly rich and complex memory.
Prerequisites: 48240

48-348 History of Central American Architecture Intermittent: 9 units

This course surveys the architecture and urbanism of Mexico and Guatemala during three critical periods of their architectural development: (1) the Pre-Columbian development of Mesoamerica, primarily Maya and Aztec (2) the Spanish colonial architecture and urbanism of the 16th-18th centuries, and (3) the 20th-century search for an appropriate regional modernism. When the Spanish conquistador Hernán Cortés landed in 1519 in what is now Mexico, he encountered one of the world's largest and most spectacular civilizations. The Aztec empire, however, was only the latest urban civilizations in a Mesoamerican tradition that stretched back more than 2,000 years. The ensuing European architectural and urban imprints can be seen as both a victory of colonialism's political, social, and architectural ideals, and as a fusion combining European practices with indigenous conditions and traditions. Centuries later, as 20th-century Latin Americans grappled with the challenges of industrialization, economic swings, and political and social revolutions, architects, planners, and clients again sought to reconcile competing visions of national and modern identities.
Prerequisites: 48240

48-350 Postwar Modern Architecture and Theory Intermittent: 9 units

This architectural history lecture course surveys the modern buildings and architectural theory of the post-World War II period. It begins with the cataclysm of WWII and the fundamental shifts it caused on the conception of modernism, technology, cities, and geo-politics. It proceeds to investigate themes such as rebuilding and reconstruction, grand modern masters such as Mies, Kahn, and Corbu, the fascination with technology, megastructures and utopian thought, the need for monumentality, meaning, and regional identity, and the dissemination of modernism from corporate America to the third world. It ends with the rupture in modernism associated with the social revolutions and the rise of a post-modern architecture in the late 1960s and early 1970s. The course includes lectures, readings, and discussions to define the unique character of the postwar period, as modernism both reigned supreme, and began to be questioned. Emphasis will be placed on the relationship of buildings to the more general cultural, intellectual, and historical circumstances in which they were created. Special attention will be devoted throughout the course to the important manifestoes, theoretical and critical writings that so determined the project of modern architecture. Work for the course involves extensive reading and a major research paper.
Prerequisites: 48240

48-351 Human Factors in Architecture Spring: 9 units

Required course Human Factors is an investigation of what makes buildings tick for people: the internal spaces, transitional spaces, transactional spaces, defensible space, owned space, shared space, public space, and most importantly, occupied space. We move up in scale from the individual and group to the community to consider our designers' biases in how we analyze the human needs, how we judge the quality of space and subsequently, how we apply this knowledge to our own design work. Students develop a research question and test it in field research using observation, interviews and surveys. They draw conclusions about the quality of a space and place and how to improve it. Students should leave this class with the ability to discern a problem, experience in applying their understanding of behavioral settings and the human condition to specific research foci, and the ability to use their knowledge and skills deftly in practice, where time and resources are limited. Assignments will be a mix of individual and group work, with emphasis on the latter. There will be an emphasis on reading relevant literature, field investigations and understanding research methods and collaboration for applications in practice.
Prerequisites: 48205

48-352 A History of Preservation: Debate, Theories and Practices
Intermittent: 9 units

The course explores selected episodes of the history of preservation, defining in the historical context the respective fields of conservation theory, restoration practices and preservation policies. A first part of the course will focus on the early history of the debate on heritage conservation, early restoration practices and the underlying progressive creation of administrative structures and official policies regarding preservation and heritage listing. (mainly in Europe, from the French revolution to the First World War). The second part will discuss the main features of modern-day approaches and problematic aspects, the broadening of the field of preservation (including urban areas and landscape preservation) and the different sensibilities involved in both decision-making and restoration practices.
Prerequisites: 48240

48-354 SCS Gates Complex Site
All Semesters: 3 units

Through visits to the Hillman Gates Computer Science Center construction site and presentations from consultants associated with the project. Students should become familiar with the physical building processes and sequence of operation. Students will develop a sensitivity to the dynamic of a construction site as an organization and as a place of production. Students will learn to read the contract drawings and specifications in the context of the full contract-managing framework. *Special Permission Required

48-400 Architecture Design Studio: Occupancy
Fall: 18 units

The Occupancy Studio raises a designer's involvement with human needs, functional and space programming, building planning and schematic design with its focus on the relationship of the building user (owner/client, occupant or visitor) to the built environment. At the crux is how an architect develops a methodology to understand the individual or aggregated occupant and assemble decoded, distilled and articulated criteria for the design of space. Studios may emphasize intellectual or theoretical approaches to user-based design, in-depth study of client needs resulting in a detailed program, or participatory design with a real or surrogate client such as a community group. Each semester offers a range of such ideas. Studio faculty varies building typology, conceptual approach, programming studies or development and historical precedent. Studios share information and project knowledge with each other. This healthy mix enlivens design process and class participation. An important aspect of the Occupancy studio and the following Systems Integration studio is understanding the application of codes and zoning requirements, which students research themselves after attending lectures on the basics of life safety, egress and the intrinsic order of code applications. Students are encouraged to work both in teams and as individuals.
Prerequisites: 48305

48-405 Architecture Design Studio: Systems Integration
Spring: 18 units

In today's climate of complex clients and large-scale architecture, design students research and discuss broad political, economic, infrastructure, management and operational systems. Following this theme and in the students' quest of building integration, they examine the complex interrelationships between performance criteria, building subsystems and their integration, specification, and evaluation. This studio is concerned with the detailed design development relating to the spatial, visual, acoustic and thermal performance of complex buildings as well as the long-term integrity of the integrated systems. Students achieve design integration of at least two building systems and their interdisciplinary objectives - structure, enclosure, interior, mechanical, communications and information, and the safety systems--addressing issues of constructability and technical innovation while combined with suitability to the user, studied in the previous semester of Occupancy.
Prerequisites: 48400 and 48412 Corequisites: 48-415

48-410 Environment II: Acoustics and Lighting
Fall: Mini Session - 3 units

This course introduces theoretical foundations and computational methods in architectural acoustics and lighting. Topics in acoustics include: a) review of physiological and psychological acoustics; b) computation of outdoor and indoor airborne sound propagation; c) interaction of air-borne and structure-borne sound with building structures; d) sound transmission between rooms; e) design methods in room and building acoustics; f) fundamentals of vibration control; g) application of computer-aided simulation tools in building and room acoustics. Topics in lighting include: a) review of visual comfort criteria and lighting psychology, b) analytical and numeric methods for the computation of lighting conditions in interior spaces, c) application of computer-aided lighting simulation

tools in architecture, d) lighting engineering and design methods.
Prerequisites: 33106 or 48115

48-412 Environment III: Mechanical Systems

Fall: 9 units
Mechanical Equipment is a study of the mechanical systems required to heat, cool, ventilate, wire and plumb a building. Students will focus on energy usage and savings for buildings along with a look at the various system types and equipment used - past, present, and future. The course parallels the AIA review class for the professional license examination, and should become a future study guide for the exam.
Prerequisites: 48105

48-415 Advanced Building Systems

Spring: 6 units
Advanced Building Systems is a required course taught in the fourth year with a direct connection to the studios emphasizing system integrations. This course introduces the concept of Total Building Performance, delineating the full range of performance mandates required for today's architecture, including building integrity. Advanced Building Systems highlights the state-of-the-art and major challenges and innovations in building technologies for structure, enclosure, mechanical, telecommunications, lighting, and interior systems. The course explores the relationships, opportunities, and conflicts of the performance mandates, and the integration of building systems necessary to achieve total building performance.
Prerequisites: 48305

48-420 City Landscape: Geography as Method and Metaphor

All Semesters: 9 units
This seminar course will explore the emergence of geography as a guiding method and metaphor in recent architecture, landscape and urban design discourse and practice. In the beginning of the twenty-first century it has become clear that the form of urban settlement is driven by complex interacting systems, ecologies and economies. With the rise of globalization and post-fordist economics, the city as landscape is required to function socio-economically at the scale of region and globe, ecologically at the scale of region and watershed, and socio-politically at the scale of community and municipality. In this situation designers are increasingly confronted with complex layered problems affecting territorial scales, and as a result advanced design has looked to other disciplines, adopting geo-graphic strategies for both analysis and formal articulation. This course will explore design's emergent geographic approach through readings, project case studies and finally with a speculative analysis and design proposal. We will examine both the key texts and projects of this emerging landscape urbanism with the thesis that the base paradigm is that of geography. In addition we will also explore texts on landscape ecology and cultural and urban geography to expand our analysis of the roles and territories that the contemporary city is expected to serve. Through the readings and project examples we will search for ways in which the use of geography and landscape can be integrated to create an urbanism capable of addressing social, economic, political and ecological issues. The project for the course will be a series of cumulative assignments to analyze and propose conceptual interventions to a site related to, but not necessarily in, the Pittsburgh region.

48-433 The Destruction and Rebuilding of Iconic Buildings and Cities

All Semesters: 9 units
This course examines the issues of the destruction and reconstruction of buildings and cities. In doing so we will be raising questions about the nature of architecture and cityscapes, cultural loss and cultural recovery, and how buildings and cities have come to represent other issues such as national identity and progress. We will examine the following case studies: the Library of Alexandria in ancient times, the burning and rebuilding of the US Capitol and the White House during the War of 1812, the burning and rebuilding of the British Houses of Parliament in the 1830s and 1840s, the looting and destruction of the Summer Palace in Beijing in 1860, the destruction and multiple reconstructions of the Mosques of Djenné in Mali during the 19th and 20th centuries, the bombing of Dresden during World War II and its subsequent rebuilding, and the destruction of, and rebuilding plans for, the World Trade Center in New York in the 21st century.
Prerequisites: 48240

48-436 History of Architecture and the Body

All Semesters: 9 units
This examines the relationships between the human form and architectural design by investigating how representations of the body have been used as ornamentation, and how architects have described spaces with the needs and constraints of the body

in mind, since ancient times. The course will provide a broad chronological overview of the historical and cultural implications of the body and architecture, and will examine a number of case studies from ancient Greek statuary to Le Corbusier's conceptions of the body's place in modernism, and will include analyses of contested uses of the body (as in Islamic architecture). Readings will range from Vitruvius to Rykwert.

Prerequisites: 48240

48-440 American Regionalism

Intermittent: 9 units

This course examines the historical development of regional patterns in the American built environment over time, from pre-colonial to contemporary times. Say "New England," and images of English Pilgrims, green town commons with white framed churches, and industrial mill villages may come to mind. "The Southwest" conjures different images, perhaps of adobe pueblos, Spanish friars, arid ranches, and all things turquoise be it jewelry or painted trim. The geographic enormity and social diversity of America is played out on the land in distinctive regional patterns. Before and after European settlement in America, Native Americans established a distinctive way of building unique to their regions and cultures. During the colonial period, different immigrant groups built distinctive settlements that reflected the confluence of era, culture, acculturation, geography, and material and human resources thus creating a vernacular pattern on the land. Regional patterns continued in the 19th century, despite the "leveling" forces of a new national identity of an independent United States of America, and of the new improvements in transportation and communications that pierced the isolation and autonomy of vernacular settlements. During the 20th century, the homogenizing influence of popular culture became, in some communities, a trend to be reversed by restoring the concepts of "place" and "history" to architecture. In addition to studying regionalism as an architectural record of a people, this course will also touch upon the role of regionalism in other arts.

Prerequisites: 48240

48-441 Frank Lloyd Wright

Intermittent: 9 units

This architectural history course investigates the career and legacy of the famous American architect Frank Lloyd Wright within the context of modern architecture. We will attempt to understand the great variety of work and ideas produced by Wright over seven decades, as well as the context which stimulated and fed off of his designs. We will focus on issues including: 1) Wright's buildings and projects; 2) the concept of organic architecture; 3) the historical and intellectual climate that gave rise to FLW's work, including the work of Richardson and Sullivan, the Shingle Style and International Style, Japanese and European modern architecture; 4) investigations of Wright's progressive clients, innovative use of building materials, changing design theories, invented building systems, radical social & political theories, broad urban experiments, and publishing prowess; 5) the influences Wright had on modern architecture worldwide, especially the tremendous influence he had in America through his own buildings, writings and lectures, as well as some 1200 disciples he trained through his Taliesin Fellowship. Work for the course involves extensive reading and a major research paper.

Prerequisites: 48240

48-447 History and Preservation

Intermittent: 9 units

This seminar investigates issues in historic preservation from a variety of historical, theoretical, and practical view points. Through intensive reading, class discussion, invited speakers, and field trips, we will explore, discuss, and write about such topics as: the history of historic preservation in Europe and America, preservation philosophies and types of intervention, designating and documenting historic structures, historic house and village museums as preservers and interpreters of history, the relationship between urban renewal and historic preservation, historic preservation as a tool of urban revitalization and cultural tourism, preservation professions. The course is generally organized by a weekly theme, with one class dedicated to discussing the history and theory of a particular aspect of preservation, and the other class dedicated to its actual practice through guest speakers or field trips.

Prerequisites: 48240

48-452 Real Estate Design and Development

Fall: 9 units

This course will introduce the Real Estate development process and explore the interdependence of development drivers and the design process. Classroom learning, exercises and guest-lectures will introduce students to the concepts of market and financial analysis, as well as the basic techniques of budgeting, proforma development, and valuation. Parallel to this investigation, students will evaluate

real world developments and interface with the development professionals that executed them to learn how development drivers shaped the development process and decision making. Students will study how market demand, tenant requirements, site constraints, and available capital affect feasibility, and through this the ultimate design solution. The semester's effort culminates in the execution of a mini-development project. Students will work in teams to complete a basic market analysis, program evaluation, schematic design, construction and development cost estimate, proforma analysis, and a determination of financial feasibility. Development practitioners will interface with student teams during this mini-project to offer "real world" guidance on student schematic designs and feasibility analysis.

48-453 Urban Design Theory and Practice

Fall: 9 units

Cities now accommodate over half of the world's population. They cover only 2% of the world's surface, yet they consume 75% of its resources. This course introduces the discipline and practice of urban design and provides a critical overview of the work of urban designers historically, and in today's context. Economic, political, social and cultural factors that have influenced urban typologies and city development will be explored, including diverse eastern and western attitudes towards the way the world is viewed and experienced, from the macro-scale of urban planning and design to the micro-scale of the human body, social relations and self organization. Issues such as increasing population growth, human migration patterns, sustainable urbanism, and the role architects, urban designers and planners can play will be discussed. Lectures, weekly readings, a group fieldwork assignment, and correlating student presentations will introduce key urban design projects and methods from the region and across the globe.

Prerequisites: Corequisites: 48-500

48-477 Making Things Interactive

All Semesters: 9 units

In this hands-on design-build class you will learn the skills to embed sensors and actuators (light, sound, touch, motion, etc.) into everyday things (and places etc.) and to program their interactive behavior using a microcontroller. Through weekly exercises and a term project the class will introduce basic analog electronics and microcontroller programming, as well as exploration into using kinetics and materials to make the things you design perform. Emphasis will be on creating innovative experiences using simple robotic technologies. Students from all disciplines are welcome: but please note that the class demands that you master technical material. Experience in at least one of: programming, electronics, or physical fabrication is strongly recommended. (Participants will provide their own supplies and materials.) Prerequisite: 15-100 or equivalent programming experience by permission of instructor.

48-500 Architecture Design Studio: The Urban Laboratory

Fall: 18 units

The Urban Lab studio at Carnegie Mellon seeks to educate architects to be leaders for vision-based change at the scales of neighborhood, city and region. It is intended to both introduce students to urban design and inform their understanding of building design in relation to existing neighborhoods. Our approach to urban design engages the city as an integrated design problem that is best solved through a participatory design process. Each year, teams of students and faculty seek to catalyze the revitalization of Pittsburgh urban neighborhoods by working with Mayors and elected officials, public agencies, private investors, and citizens of communities to collectively envision physical change within their neighborhoods and communities. Without being direct providers of technical assistance for communities, the Urban Laboratory has used the educational qualities of the urban design studio to build long-term university-community partnerships and ultimately build the capacities of communities to be their own drivers of change. Equally important to introducing the participatory process in urban design, the Urban Lab also emphasizes the importance of collaborative, multi-disciplinary design and decision-making. Students expand architectural design skills and gain new skills in urban design, planning and community leadership. In short, the Urban Lab represents the culmination of the architectural educational experience, by expanding existing skill sets, dramatically increasing the scale of intervention, and introducing a real client—the community.

Prerequisites: 48405

48-505 Studio X

Spring: 18 units

This project-based thesis studio offers the opportunity for creative understanding, spatial experimentation and architectural consolidation. The thesis is to be enriched by a dynamic process of discovery during the development of the project. The thesis

project grows out of this exploration and does not precede it. A well researched, clearly articulated thesis project develops the student's individual architectural voice. Working from one's own comprehensive knowledge in architecture to date, theory, humanities, history, cultural criticism, philosophy, music, art, etc., the successful thesis project challenges us to question our convictions about architecture and urban design. The goal of the architectural thesis is to demonstrate such creative understanding and be able to sustain critique at various levels of interpretation, project resolution and enquiry. *Students can also fulfill Studio X via a School of Architecture approved Study Abroad Experience.
Prerequisites: 48105

48-512 Contemporary Architectural Theory II

All Semesters: 9 units

This is the second course in a sequence on Contemporary Architectural Theory, but the first is not a prerequisite. As a counterpoint to the first course which considered philosophical, literary and cultural theory as broader interpretive frameworks, this course will emphasize theoretical texts which document and contextualize the specific conceptual and physical processes of generating space, form, and detail in contemporary architectural design, in structures whether real or virtual, built or represented. Authors will include but not be limited to Herzog & de Meuron, Toshiko Mori, Kenneth Frampton, Gregg Lynn, Winy Maas, Michael Bell, Zaha Hadid, and Daniel Libeskind. This course will operate as a seminar and depend significantly on student participation in discussions and presentations. It will include a significant section of student-suggested readings.

48-531 Fabricating Customization

All Semesters: 9 units

This seminar/workshop seeks to explore the premise that architecture is once again at the threshold of a significant shift related to its making. We, the architectural community, will inherit the result of an evolving system of mass production. Will we push its boundaries and seek alternative forms, standards and tectonics or simply allow the result to be driven by others? What can we learn from the studies of our predecessors? Lately, terms such as mass customization, that is variation within the manufacturing framework of mass production, have emerged as buzzwords within architectural discourse. Economists and industry leaders tell us the heyday of mass production is over. Speculative projects from the scale of building components to buildings themselves provide insight towards alternative methods. The broad profession of architecture however, remains constrained by the system of mass production. As manufacturing technology advances this is increasingly a mindset not a limitation tied to manufacturing processes. Through an in class presentation and collaborative design projects, students will utilize digital fabrication technologies to design and prototype a responsive architectural component or system. Students will be expected to work collaboratively in small groups through a research and design project.
Prerequisites: 48125

48-539 Performance Driven Composite Surfaces

All Semesters: 9 units

Through design and fabrication processes that are informed by how various surfaces can perform, students in this class will develop a large scale architectural installation that speculates upon the potential found within combinations of standard materials. The material relationships will provide the framework to transform the traditional assumptions of a material and produce hybrids. Particular focus will be devoted to structural, acoustic and visual performance as they relate to the creation of space. The installation from this class will be a collaborative project. As such, all participants will be required to work closely through all stages of the project. Given the design build nature of the class, students should expect to physically produce a significant body of work. This class will rely upon the DFab within the SOA and therefore requires digital modeling proficiency. Students will learn the fundamentals of a select number of CAD/CAM processes but will be expected to build upon these skills outside of the context of formal lectures. Since the SOA will provide a material budget for the class, students should not expect to incur significant material costs.
Prerequisites: 48125

48-550 Issues of Practice

Fall: 9 units

Issues of Practice is a required course taught in the fifth year. It consists of three modules: Personal Promotion, Emerging Professional's Companion, and Excursions. The Personal Promotion module provides the students with a framework to create a resume, cover letter, and portfolio. The EPC (Emerging Professional's Companion) provides concentrated study in different aspects of professional practice. The Excursions require students to see

how architecture relates to the wider world with architecturally related events that can include volunteer opportunities, lectures, mentorship, or teaching.

Prerequisites: 48105

48-551 Ethics and Decision Making in Architecture

Spring: 9 units

Ethical Decision Making in Architecture is a required course in the fifth year of the Bachelor of Architecture Degree. It is part of a sequence dealing with professional aspects of the field of architecture, alongside courses like Human Factors, Real Estate Design and Development, and Issues of Practice. It builds on an understanding of the issues of occupancy, economics and practice in design decision making. The course covers basic frameworks of decision making and ethical adjudication through several case studies including Fallingwater, Sydney Opera House, Citicorp Tower, Pruitt-Igoe housing development, Crystal Palace and Kansas City Hyatt. The text for the course is a manuscript by the instructor entitled "Ethical Decision Making in Architecture".

48-564 Furniture Design & Construction

Fall: 9 units

The projects for this course will consist of two functional objects. The first will last for 3 weeks and is designed to re-familiarize students who haven't used the shop recently to its machinery and standard processes. During its duration some traditional hand skills will also be introduced. This first project will challenge all students, including experienced users, to understand how process can generate form/pattern and the different character of these form/patterns. The students will be required to integrate these patterns into an interwoven expression. The second and major project will last the remainder of the semester. It will be a functional piece of furniture with specified design parameters. An assignment for studying an artifact or structure in the urban environment through sketching and photography and research will be issued. This study will become the starting point for the design of the object. Materials will be procured before mid semester. The project will be due, and a review will be scheduled during the final exam period at a good time for all participants.

Prerequisites: 48105

48-568 Advanced CAD, BIM, and 3D Visualization

Fall: 9 units

This class is designed to introduce a person to advanced CAD commands, including AutoCAD 3D, 3D Studio MAX, and Autodesk REVIT. Students will learn how to properly set up and manipulate CAD projects integrating all three software applications, replicating real world projects in leading architectural firms. Building information and parametric modeling, animations, materials, lighting, and rendering concepts will allow students to create integrated projects, 3D video animations, and realistic renderings. At the conclusion of this course, students will have projects and animations created and architectural CAD standards outlined. Students should have some familiarity with basic AutoCAD 2D commands. Those who don't have AutoCAD 2D knowledge can contact the professor to arrange for on-line tutorials that need to be completed before classes begin.

Prerequisites: 48305

48-569 GIS/CAFM

Spring: 9 units

Geographic Information Systems (GIS) are computerized systems designed for the storage, retrieval and analysis of geographically referenced data. GIS uses advanced analytical tools to explore at a scientific level the spatial relationships, patterns, and processes of cultural, biological, demographic, economic, geographic, and physical phenomena. Facilities management is the practice of coordinating the physical workplace with the people and work of the organization. FM integrates the principles of business administration, architecture, and the behavioral & engineering sciences. Computer Aided Facilities Management (CAFM) integrates various tools that demonstrate the use of software in facilities management to streamline operations, boost productivity and develop strategic planning goals for an organization. Application areas covered in this course include city and regional planning, economic development, education, elections, and environmental studies, housing and property evaluation, transit and transportation issues, land use, crime analysis, emergency management, census population and demographic studies, health and business uses, 3D modeling, space planning, asset management, building operations, real property and lease management, and telecommunications.

Prerequisites: 48120

48-576 Mapping Urbanism

Intermittent: 9 units

The aim of this course is to provide the critical tools necessary to examine the city as both a representation and a reality in flux. Through an interdisciplinary framework we will study urban history, theory, visual thinking and information design. Weekly lectures will introduce world cities and their typologies – e.g. the classic city, the shrinking city, the growing city and the megalopolis. Through readings, films, and class discussions that highlight the juxtaposition of socio-economic and physical factors, students will gain a more sensitive and holistic understanding of urban issues. Parallel to these urban explorations, we will study and employ a diverse set of tools with which to map urbanism, including traditional mapping techniques such as Nolli plans and Sanborn maps; cultural critiques of world map projections and tourist maps; and contemporary experimental explorations which draw from art, architecture and interactive web design. Weekly assignments will include student projects and presentations that synthesize required readings, writing and mapping. The final outcome will involve city case studies and the utilization of various representational techniques to create inventive mappings, possibly documented in a multi-media format. Our aim will be to learn new ways of seeing and portraying the city.

48-577 Contemporary Middle Eastern Cities

All Semesters: 9 units

Contemporary Middle Eastern Cities The Middle East is home to some of today's most dynamic urban conglomerations, some of which may provide models for development in other areas of the world. Regardless of their age, the ancient city of Istanbul, the medieval city of Baghdad, the modern city of Tel Aviv, or the contemporary city of Dubai, all address issues of the twenty first century (e.g. burgeoning populations, the environmental impact of rapid urbanization, and post-disaster reconstruction, both natural and man-made), with varying degrees of success. We will examine these issues by looking at both cultural context and physical form. Students will be encouraged to look at large scale, regional effects of urbanization as well as smaller interventions within a given neighborhood, and to search for the interrelation between the two scales. The course will examine several of the region's significant cities in a case study model. Students will present to their peers their research findings for a given city and will prepare work that will culminate in a final project that represents a synthesis of their research. It is expected that students will respond in both writing and drawing, utilizing information design as a means of expressing their findings.

48-587 Architecture Lighting Design

Intermittent: 9 units

Architectural Lighting Design is an elective course open to undergraduate and graduate students. It presumes no previous knowledge in lighting design. Analyzing visual examples of light in art, theatre, film and nature, the course demonstrates how lighting affects not only what we see but how we see it and how we feel about it. Once the students have a basic understanding of light and its' physical properties they apply this knowledge to designing architectural applications.

Prerequisites: 48105

48-588 Contemporary Architectural Theory I

Intermittent: 9 units

Contemporary Architectural Theory is less of a description than a collection of three contentious terms. Current architectural discourse can search for innovative form or the mechanisms of meaning. More crucially, it can seek critical assessments of political, economic, and environmental forces. It may use the language of philosophy, literary and cultural criticism, economic and political analysis, popular culture or social activism. The purpose of this course is to read from the literature of the numerous methodological and disciplinary approaches that fit under the loose rubric of contemporary architectural theory to develop students' skills in critical thinking about and clear communication of the complexities of current architectural discourse. Authors will include but not be limited to Jean Baudrillard, Jean-Francois Lyotard, Michel Foucault, Fredric Jameson, David Harvey, Saskia Sassen, Diane Ghirardo, Keller Easterling, Michael Bell, Sanford Kwinter, Jeffrey Kipnis, Manuel de Landa, Paul Virilio, Sylvia Lavin, and Saskia Sassen.. It will include a significant section of student-suggested readings.

Prerequisites: 48105

48-595 Under the Influence: Architecture & Art I

Intermittent: 9 units

Under the Influence: Architecture and Art is an elective course taught in the spring semester. Many of the world's leading architects cite art and cinema and other cross disciplinary factors among their most significant inspirations. Rather than basing their successful

architectural practices on narrowly focused foundations, these architects boldly cross borders into the worlds of music, fashion, photography, film, art. New York architects Scofidio & Diller reference Marcel Duchamp, Rem Koolhaas and Herzog & deMeuron design for Prada, Peter Eisenman acknowledges the writings of Robert Morris among other artists, and Bernard Tschumi has based buildings on the editing principles of Sergei Eisenstein...The list goes on. At the same time, many contemporary filmmakers look to architecture for their conceptual framework. Why are these artists and architects looking outside of their disciplines to cross over into each-others worlds for inspiration and direction? What are they learning and how are they applying their discoveries? What can we learn from these leading figures and how can we ourselves begin to cross borders to develop new working methods and approaches that will advance our own professional and creative processes? These are some of the questions that the course addresses.

Prerequisites: 48105

48-596 LEED Buildings and Green Design

Spring: Mini Session - 6 units

Green building and sustainable design have been rapidly gaining acceptance in all sectors of the building market. Global issues of energy use, emissions, resource depletion, and land use are forcing building professionals to re-evaluate standard design and construction processes, and look to more environmentally friendly practices. The U.S. Green Building Council (USGBC) developed green building rating systems entitled Leadership in Energy and Environmental Design (LEEDTM) in order to define "green building" by establishing a common standard of measurement. LEED considers green building methods and technologies in several categories including site, water, energy, materials, and indoor air quality, and awards points towards an overall green building rating of certified, silver, gold or platinum. Currently, LEED registered projects make up 3% of the current U.S. commercial building market, and Pennsylvania is the third leading state with LEED registered projects. There is now a demand for design professionals with knowledge and experience not only in sustainable design but specifically with the LEED rating system as well. This course will provide students with background knowledge of the USGBC, the LEED system, as well as referenced standards related to specific topics. The course will benefit greatly from the large number of LEED projects in the Pittsburgh region, which will serve as case studies. Upon completion of the course, students will be prepared to take the LEED Professional Accreditation Exam, which is quickly becoming the standard of recognition for green building professionals.

Prerequisites: 48315

48-711 Paradigms of Research in Architecture

Fall: 9 units

This course is both an introduction to important models and methods of academic research particularly as they are related to building design issues and a forum for intellectual curiosity. During the initial ten weeks of the semester, the course presents an overview of the field and covers several models of research as they relate to the building design. These will include models of natural sciences, social sciences, sciences of the artificial, engineering and aesthetics in building design. During the final five weeks of the semester faculty both CFA and CIT will be invited to make presentations about their areas of research and the methods they use. These presentations correspond in many respect to those covered in lectures.

48-722 Building Performance Modeling

Fall: 12 units

This course introduces fundamentals and computational methods in building performance modeling. Topics include: modeling and design, overview of thermal, visual, and acoustical domain knowledge, integration of performance simulation in computer-aided design, introduction to the application of advanced computational building simulation tools, case studies and design assignments on the application of simulation in the evaluation and improvement of building performance.

48-725 Real Estate Design and Development

Fall: 12 units

This course will introduce the Real Estate development process and explore the interdependence of development drivers and the design process. Classroom learning, exercises and guest-lectures will introduce students to the concepts of market and financial analysis, as well as the basic techniques of budgeting, proforma development, and valuation. Parallel to this investigation, students will evaluate real world developments and interface with the development professionals that executed them to learn how development drivers shaped the development process and decision making. Students will study how market demand, tenant requirements, site constraints,

and available capital affect feasibility, and through this the ultimate design solution. The semester's effort culminates in the execution of a mini-development project. Students will work in teams to complete a basic market analysis, program evaluation, schematic design, construction and development cost estimate, proforma analysis, and a determination of financial feasibility. Development practitioners will interface with student teams during this mini-project to offer "real world" guidance on student schematic designs and feasibility analysis

48-729 Productivity, Health and the Quality of Buildings
Intermittent: 9-12 units

Given the growing demand for green buildings by federal and private sector clients, professional practices are "tooling up" all over the world to deliver high performance, environmentally responsive, "green" buildings and communities. However, investments in green, high performance building solutions and technologies are still limited by first cost decision-making, and life cycle tools are still largely inaccessible to professionals. A new building investment decision support tool – BIDS™ - has been developed by the NSF/IUCRC Center for Building Performance at Carnegie Mellon University, with the support of the Advanced Building Systems Integration Consortium. This cost-benefit decision support tool presents the substantial cost-benefits of a range of advanced and innovative building systems designed to deliver – privacy and interaction, air quality, ergonomics, lighting control, thermal control, network flexibility, and access to the natural environment - from field case studies, laboratory studies, simulation studies, and other research efforts. This course will explore the relationship of quality buildings, building systems, and land-use to productivity, health, and well-being. The course will engage students in the literature relating building design decisions to ten cost/performance impacts: energy, facilities management, organizational change, technological change, attraction/retention (quality of life) of employees, individual productivity, organizational productivity, salvage/ waste, tax/ insurance/litigation, and health. Instructor(s): Vivian Loftness

48-739 Making Things Interactive
All Semesters: 9-12 units

In this hands-on design-build class you will learn the skills to embed sensors and actuators (light, sound, touch, motion, etc.) into everyday things (and places etc.) and to program their interactive behavior using a microcontroller. Through weekly exercises and a term project the class will introduce basic analog electronics and microcontroller programming, as well as exploration into using kinetics and materials to make the things you design perform. Emphasis will be on creating innovative experiences using simple robotic technologies. The graduate edition of this course will require additional work including a paper that can be submitted to a peer-reviewed interaction design conference such as CHI, UIST, or TEI. Students from all disciplines are welcome: but please note that the class demands that you master technical material. Experience in at least one of: programming, electronics, or physical fabrication is strongly recommended. (Participants will provide their own supplies and materials.)

48-752 Zero Energy Housing
Fall: 9 units

Traditional American methods of homebuilding are not adequately responding to the need for flexible, affordable, energy effective and resource efficient homes. This elective looks at the housing delivery process in response to global and regional change. From climate change, to power deregulation, to suburban sprawl to the rapid proliferation of information technology, change is occurring at a more rapid pace than at any other time in our history. Yet, the housing industry is a fragmented, multi-headed beast in which change is slow to occur, if at all. Our houses of today are not meeting the needs of the users, nor are they performing as good "global" citizens. Applying industrial engineering principles to the housing delivery process could potentially offer solutions to directly solve these problems. History however, shows us that the houses constructed in this fashion, from the panelized houses of Konrad Wachsmann and Walter Gropius to Operation Breakthrough and HUD-code homes, have not been the solution to our housing needs. While these historic efforts introduced new technologies and processes, they were not fully integrated into the structure of the domestic homebuilding industry. Japan and the European Community, faced with higher energy costs and higher density settlement patterns, have been leading the way globally with innovative ideas and financial incentives to produce better housing. This course will focus on the integration of design, technology and construction process as a strategy to achieve zero energy homes and communities.

Design

51-101 Design Studio I
Fall: 9 units

This studio course introduces students to the fundamentals of two- and three-dimensional design. Through a wide range of exercises and projects students explore what it means to communicate with form and images. The course will cover the use of visual and physical elements in design, with emphasis placed on idea and form development, visual organization, construction, understanding materials, and considering how people draw meaning from form. This course is for undergraduate design majors only.

51-102 Design Studio II
Spring: 9 units

This course is designed to provide a series of experiences that prepare students for a major in Industrial or Communication Design. Through the exploration of form and content students begin to develop their abilities to design in more complex social situations. This course seeks to develop perceptual and expressive abilities that allow for thorough interpretation of design problems. Students work as individuals and as members of teams to develop an understanding of design process. Student evaluation is based on faculty critique of projects at different stages of development in a studio setting, with the participation of students. This course is for undergraduate design majors only.
Prerequisites: 51101

51-121 Design Drawing I
Fall: 9 units

Drawing is an essential tool that designers use to communicate, develop, and test their ideas. This basic drawing course is designed to introduce students to a variety of drawing approaches related to the design process. Students learn methods of representation, communication, idea generation, and form development. A sequential approach to the understanding of structure, form, space and the effects of light through the use of line, tone and texture will be stressed. Students will be introduced to a variety of simple drawing media. Drawing in this context is viewed as a means of design thinking, with emphasis placed on the analysis and interpretation of existing man-made and organic forms. Demonstrations and group and individual critiques augment concepts presented in class. This course is for undergraduate design majors only.

51-122 Design Drawing II
Spring: 9 units

This course introduces drawing systems and diagrammatic conventions while further developing the principles covered in Design Drawing I. Exploration, analysis, refinement and communication of design concepts are the main issues covered in this course. Perspective systems and diagramming are used to understand, communicate and express various forms of information. Projects reinforce freehand sketching and provide the basis for introduction to more complex drawing media. Demonstrations and group and individual critiques reinforce concepts presented in class. This course is for undergraduate design majors only.
Prerequisites: 51121

51-132 Introduction to Photographic Design
Spring: 9 units

Introduction to photography for designers through digital photography. Using a digital camera, students learn how to extend their 'seeing' with the camera, both in the world and in a shooting studio. Through shooting assignments in the world we will see how photography is another means of image-making for designers who need to know how to read photographs as well as how to make them. In the shooting studio, students will learn basic documentation skills and how to make digital portfolios of their two-dimensional and three-dimensional work. In addition to making photographs, we will look at different kinds of existing photographic imagery, e.g. documentary, advertising, scientific, fine art-to gain an overview of the medium and learn how photographs effectively communicate information. Shooting assignments in and out of the studio, critiques, and library research. Required for all design majors; lab fee; digital camera necessary.
Prerequisites: 51101

51-171 Human Experience in Design
Fall: 9 units

This course introduces the central theme of design and the design professions: the importance of human beings in all aspects of design thinking and practice. We will begin by exploring design and the human dimension, discussing the nature of human beings and their physical, psychological, and spiritual or cultural needs. Then, we will consider the role of human beings in the design process, exploring

how designers respond to human needs and issues of value. Finally, we will discuss the scope of design in our personal, social, and cultural environment, observing how thoroughly design has permeated our lives through images, physical objects, services, and environmental systems, extending even to a profound impact on the ecological system of the planet. This is the first course in the Design Studies sequence of the department. Lectures, discussions, and written assignments, with readings and extensive visual materials. Required for all design majors.

51-201 Basic Typography Communication Design I
Fall: 9 units

This is the first studio for students in the communication design program. Students explore the fundamental principles of typography, where type is regarded as an image that serves a variety of communicative purposes. Projects allow students to explore issues of form and meaning, hierarchy, legibility and readability, structure and composition, and the design process. While typography is a highly focused branch of communication design, this introduction to type as image serves to open a path for students to study all facets of communication design in subsequent courses. Students use both traditional materials and design tools as well as computers. Special tutorials provide basic instruction in software such as InDesign and Adobe Illustrator. In addition, we will also discuss some of the key figures, philosophies, and technologies that have shaped typography. The course will also include a demonstration of letterpress operation in the Design Department's Lab Press and a guided visit to the Hunt Library's Rare Book Room. This course is for undergraduate Communication Design majors only.
Prerequisites: 51102

51-202 Intermediate Typography
Spring: 9 units

The theme of this course is the integration of type and image. The primary goal of the projects is how to achieve a harmonious and effective interplay of typography and imagery to express meaning. Through a confident use of grids, color, images, type, and visual hierarchy, students will explore a variety of solutions to design problems that require both expressiveness as well as an understanding of the practical uses of communication design. With an emphasis on formal and semantic issues, assignments will demonstrate how typography, photography, and other forms of image making may be combined to shape the form and content of communication. This course is for undergraduate Communication Design majors only.
Prerequisites: 51201

51-203 Communication Design Computer Lab
Fall: 3 units

This sophomore level Communication Design course introduces students to the software required to generate communication design pieces. Software will be introduced in a way that coincides with the Basic Typography assignments. CD majors only, or permission of the instructor.

51-211 Generation of Form: Industrial Design I
Fall: 9 units

Generation of Form is the first studio for students in the industrial design program. Students explore product aesthetics and basic formal issues as they pertain to industrial design. This course integrates the principles of three dimensional design, drawing and prototyping as they apply to the generation of product form. Emphasis is placed on issues that dictate the form of products and their creation. Students develop basic prototyping, conceptual drawing, and presentation skills for the purpose of exploring, analyzing, refining and communicating design concepts. Required of ID students; lab fee. Due to space constraints, this course is only offered to undergraduate Industrial Design majors.
Prerequisites: 51102

51-212 Meaning of Forms: ID Studio II
Spring: 9 units

This studio course introduces students to semantic and symbolic aspects of industrial design. Several projects are given and students are required to develop studies that express the functional and cultural meanings of products. Students use various methods of conceptual sketching, detailed documentation, and prototyping; lab fee. Due to space constraints, this course is only offered to undergraduate Industrial Design majors.
Prerequisites: 51211

51-222 Color and Communication
Spring: 9 units

As a communication tool, color can signal, enhance, and speak in ways that type and images cannot. Combined with type and

images, color can contribute to the persuasive and communicative force of design. Beginning with a perceptual understanding of color, this course will explore the many ways that color communicates. Students will work with traditional materials and tools as well as computers to understand the strengths and limitations of each, comparing their similarities and differences in the context of theoretical and applied projects. This course is for Communication Design majors only, or by permission of the instructor.
Prerequisites: 51201 or 51211

51-224 Digital Pre-Press Production
Spring: 9 units

A lecture/lab exploration of the processes and materials of the printing industry as they support and condition the work of the communication designer. The role of electronic publishing tools in the preparation of finished art will be emphasized. Field trips to a printer and an electronic pre-press facility, as well as guest lectures from industry, keep this course up-to-date; lab fee. This course is for undergraduate Communication Design majors only, or by permission of the instructor.
Prerequisites: 51201

51-227 Marks, Signs and Communications
Intermittent: 9 units

In this studio course you will design a variety of marks ranging from trademarks, (logos), logotypes, icons, wayfinding devices and potential symbols. You will be exposed to many examples of marks for reference, acquire an understanding of the design process and develop the confidence of how marks fit into a communication strategy. This course is for undergraduate Design majors only, or by permission of the instructor.

51-229 Digital Photographic Imaging
Fall: 9 units

This course is a Communication Design sophomore requirement. Students will explore conventional and digital means of image making. Students will gain in-depth exposure to digital manipulation through Adobe Photoshop as well as developing skill sets concerning digital input and output. The techniques learned will facilitate students' delivery of content in their images. Instructor permission required for non CD sophomores.

51-231 Calligraphy I
All Semesters: 9 units

Working with pure unadorned Roman letterforms, this course will introduce the student to the theory and practice of hand-generated letters, employing a variety of mark-making tools. This course provides an in-depth understanding of the basic principles and techniques of the art of formal writing. Rhythm, texture and composition are achieved through routine, elementary exercises using geometric forms, demanding concentration and manual discipline with the development of hand-eye coordination. The function, use, and harmonious sequencing of letterforms will be taught through weekly projects. Awareness of rhythm, texture and letterform structure are achieved through routine exercises. Drills, demonstrations, discussions, individual and class critiques are on-going. Additional related topics and activities introduced in class include Books: binding and design. Brief introduction to the historical development of our Western alphabet through film, slides, demonstrations, with discussion of twentieth-century type designs. Letter vocabulary, paleography, monoprints, words and punctuation. Classical page design. Publications past and present. Calligraphy's role in design today. Thinking with hands and eyes, the manual placement and spacing of letters practiced in this course awakens sensitivity and judgment in the designer.

51-232 Calligraphy II
All Semesters: 9 units

Continuation of Introduction to Calligraphy I. Advanced problems in calligraphy and lettering. New hands are introduced, to be decided by student and instructor.
Prerequisites: 51231

51-241 How People Work
Fall: 9 units

51241 How People Work: Human Factors (ID/CD Lab I) This course is a general introduction to the field of human-centered design and applied human factors. It centers on the understanding of physical, cognitive, and emotional human needs and desires, including methods employed to acquire this information and translate it into useful criteria for the design and evaluation of products. Lecture, discussion, lab exercises, and projects are employed. Required of all sophomore design students. Due to space constraints this course is for undergraduate Design majors only.

51-242 How Things Work: Mechanics and Electronics

Spring: 9 units

This course investigates the basic principles of mechanics and electronics. Through the combination of lectures, investigations, and lab experiments, students develop simplified representations of complex systems. The skills of freehand drawing, mechanical drawing and three-dimensional models are employed and developed during the project sequence. Required of ID students. Instructor permission required for non-ID majors.
Prerequisites: 51211

51-243 Prototyping

Fall: Mini Session - 4.5 units

A half-semester laboratory mini-course introducing a range of materials, methods, and workshop techniques by which designers prototype designs in three dimensions. Basic competence in shop techniques is established by bringing to realization a series of simple artifacts. Studio and model shop tools are required; lab fee. This course is for ID majors only.

51-246 Photo Documentation

Spring: Mini Session - 4.5 units

This course teaches Industrial Design students basic lighting and camera techniques for documenting three dimensional design work digitally. Required for all ID students.
Prerequisites: 51211

51-251 Digital Prototyping

Fall: Mini Session - 4.5 units

A half-semester laboratory mini-course introducing 3D modeling software. Course Structure Each class meeting will consist of an introduction to and demonstration of specific aspects and functions of SolidWorks. At the end of each class session, work related to the covered topic(s) will be assigned for completion by the next class meeting. This course is a requirement for all ID majors. Instructor permission required for non-ID majors.

51-261 Communication Design Fundamentals

Fall: 9 units

A one-semester course that introduces non-majors to the field of communication design. Through studio projects, lectures, and demonstrations, students become familiar with the visual and verbal language of communication designers, the design process, and the communicative value of world and image. Macintosh proficiency required. This course is required for HCI double majors and Design minors. All students must visit the design office in MM 110 during registration week, and fill out a form to request a seat in this course. Section W - Qatar campus only

51-262 Communication Design Fundamentals

Spring: 9 units

A one-semester course that introduces non-majors to the field of communication design. Through studio projects, lectures, and demonstrations, students become familiar with the visual and verbal language of communication designers, the design process, and the communicative value of world and image. Macintosh proficiency required. Because of the heavy demand for this course, students must visit the Design office in MM 110, and fill out a form requesting a seat in this course, during registration week.

51-263 Industrial Design Fundamentals

Fall: 9 units

A one-semester course that introduces non-majors to product development from the industrial designer's point of view. Through studio projects, lectures, and discussions, students will gain experience in visualizing a product for mass production. Case histories and the analysis of existing products will supplement hands-on experience in developing product concepts. This course is required for all ID minors.

51-265 Black and White Photography I

Fall: 9 units

Introduction to the methods and practices of black and white photography, including darkroom practices. 35mm camera required; lab fee.

51-271 Design History I

Fall: 9 units

This course provides an overview of design history from 1850 to 1950, the critical period for the formation and development of design and the design professions. There are three primary goals. The first is to provide an understanding of the role that design has played in the evolution of the competitive free market system at national and global levels. The second goal is to demonstrate how design emerged as a powerful tool for corporate and cultural identity in this

period. The third goal is to develop an understanding of some of the basic influences on the formation of design theory and practice in the twentieth century. This is accomplished through the presentation and discussion of primary economic and cultural forces, philosophical ideas, artistic and social movements, and significant individuals and artifacts that represent the period. The course traces both the chronological and the contextual development of design, providing students with an understanding of design as an evolving concept. This course is required for Design majors and Design minors.

51-272 Design History II

Spring: 9 units

This course focuses on the development of design from 1950 to the present, with further exploration of the themes introduced in Design History I as well as the introduction of new themes that have emerged to influence the direction of design thinking. The themes range from design for communities, to personal visions of individual designers, to the needs and expectations of society. The course explores the relationship between design and gender, race, the environment, political systems and social change. Students develop an in-depth understanding of these themes through lecture, research and presentations. This course is open to Design majors, BHA Design students, Design Minors, and by permission of the instructor.

51-274 Design and Social Change

Spring: 9 units

In this course we will examine the important relationships of history, culture, policies and the environment in communication design and industrial design. Conversely we will study the ways in which design can affect our culture and environment, both positively and negatively. Topics include: sustainability, universal design, system thinking and system visualization. While various cultures will be acknowledged and discussed, the major emphasis will be on Western culture. Through lectures, videos, reading and projects, students will develop their ability to incorporate historical context and consideration of potential consequences into their design process.

51-301 Advanced Typography CD III

Fall: 9 units

This course develops advanced skills in typography and communication design, including the study of type and motion. Students learn to conceptualize and visualize more complex bodies of information for a variety of communicative purposes. Projects encourage students to develop a deeper understanding of the expressive potential of type and image and to develop critical and creative thinking skills with which to assess the effectiveness of their own work and that of their peers. Course objectives are to encourage an active exchange of ideas and information which allow students to develop the ability to clearly articulate their ideas and thought processes in relation to their work. This leads to a more focused method for developing and expressing ideas effectively. Instructor permission required for non-CD majors.
Prerequisites: 51202

51-302 Typography IV

Spring: 9 units

The world is complex, and we have made it so. This course is a creative venture that deals with complexity, in particular the complexity of visual information that surrounds us in our daily lives. From train schedules to tax forms to the user guide for a VCR, humans have created a typographic labyrinth within which we are often lost. This course deals with the basic principle that communication designers employ when they represent complex information, making it visible and accessible. Assignments are specific, but their lessons are fundamental, providing students with conceptual and visual tools that will help to solve any information design problem. Instructor permission required for non-CD majors.
Prerequisites: 51301

51-311 Product Design ID III

Fall: 9 units

Course projects are chosen to give students an opportunity to use their creative, technical and theoretical skills in a business application. The primary emphasis is on the use of a systematic process for the design and development of products that are useful, usable, desirable and feasible. Attention is also given to designers' interaction with engineering, marketing, and other professionals who influence the product development process. Studio, model shop tools and a digital camera are required; lab fee. Instructor permission required for non-ID majors.
Prerequisites: 51212

51-312 Products in Systems: ID IV

Spring: 9 units

This course introduces the themes of product planning and the development of products within systems and as systems. The projects are broad in scope and require students to develop products that reflect an understanding of the entire development cycle. Tools and skills for the studio and model shop are required; lab fee. Instructor permission required for non-ID majors. Prerequisites: 51311

51-316 Designing Spaces

Intermittent: 9 units

Stop. Look around you. Where are you and what are you doing? Are you in a lecture hall? A gallery? The check-out line at the "O"? How does the layout of the space support the activity that's supposed to happen there? How big is the space, and how is it proportioned? If you added ten feet to the ceiling height, how would it change the way it feels? Look down at your feet. What material are you standing on? Does it feel soft beneath your feet? How does it affect the sound quality of the room? Imagine it as a bright orange surface. What if the walls were rough instead of smooth—how would they catch the light differently? Does the sunlight come into the space, casting shadows? Or is the light primarily artificial, and what are the fixtures like? What, in sum, does it feel like to be in this space and what are the elements that define it? This course will present you with the opportunity to consider some of these questions, and will allow you to look at spatial issues from your perspective as a designer. The semester will be divided into sections exploring issues such as program, site, structure, material, and light, and each section will be supported by a series of exercises, lectures, and short projects. Designing Spaces should be of particular interest to those interested in pursuing exhibit design, interior design, and wayfinding design, but it may also be useful simply as a way of expanding your design framework. This course is open to junior and senior ID and CD students, and has no prerequisites

51-321 Photographic Narrative

Intermittent: 9 units

Most photographs tell stories. We see photographs in newspapers, magazines, snapshot albums, on the web, in books, and in posters. In these contexts photographs often work with words to convey meaning, whether they are shown with captions, news stories, or just with titles. Photographs can work without words, too, to create purely visual narratives. In this course, students will make two series of photographs: one that is fiction and one that is non-fiction. In addition to making photographs, students will determine the context in which their photo-stories will be seen. Students may make photo books, for example, or decide that their images will be seen on a website. While students are making photographs, we will explore the rich traditions of photo-graphic story-telling that range from the world-oriented work of photo-journalist W. Eugene Smith to the documentarians such as Walker Evans, Nicholas Nixon, and Alec Soth. We will look at photographers, too, who constructed private worlds, such as Duane Michals, Cindy Sherman, Bruce Charlesworth, and Laurie Simmons. As students explore both fiction and non-fiction through photographs, we will look at the interesting interplay between words and photographic images; how images are paced and scaled to create tempos; how photographs are sequenced to tell stories; and other formal elements involved in creating visual narratives. 12-15 students Prerequisite—a college level photography course. Prerequisites: 51221 and 51221

51-323 Drawing and Communication

Intermittent: 9 units

This course explores drawing as a means of communicating and expressing ideas. We will explore drawing by hand, but there will be some integration of other imaging technologies. Themes will center around objects, people, and places in various contexts. Emphasis is placed on individual interpretation and exploration of the assigned projects. Each project has several components that cause the student to generate and develop ideas as they work towards more refined images. Specific conceptual and technical skills will be discussed both individually and in groups as students examine the relationship between images and meaning. Instructor permission required for non-Design majors. Prerequisites: 51122

51-324 Basic Prototyping Methods for CD

Spring: Mini Session - 4.5 units

A half-semester laboratory mini-course introducing a range of materials, methods, and workshop techniques by which designers prototype designs in three dimensions. Basic competence in shop techniques is established by bringing to realization a series of

simple artifacts. Studio and model shop tools are required; lab fee. Instructor permission required for non-CD majors. Prerequisites: 51201

51-325 Signs/Symbols/Marks

Intermittent: 9 units

This course focuses on the formal development of pictorial signs (icons, symbols, marks, etc.) either as individual elements or as families and systems of compatible forms. Through a variety of projects, students will employ an analytical process, which includes research, observation, idea generation, development, selection, and refinement of images. We will explore the personal, social, and cultural messages that such images carry. There will be applications in two- and three-dimensional formats. Instructor permission required for non-Design majors. Prerequisites: 51202

51-326 Documenting the Visual

Intermittent: 9 units

A critical look at documentary photography. We will examine 19th and especially 20th century images to see how photographers have shaped and extended a tradition that continues into the present. We will discuss theoretical issues?e.g. how cultural context influences the making and understanding of photographs; how photographers use both conscious as well as unconscious strategies in image-making; how documentary images take different forms—ranging from seemingly literal and objective descriptions, to intensely personal statements, to images coupled with text. In exploring these issues, we will look at a variety of image-types: family and candid photos, company and advertising photos, political and humanistic or social photo-essays. Extensive visual materials, readings, written and optional photo assignments. Intended for students majoring in the Department of Design or the Department of English, or by permission of the instructor.

51-327 Introduction to Web Design

Fall: 9 units

This class will introduce the basics of setting up a web site, as well as the fundamentals of XHTML, CSS, and Flash to assist students in creating semantically correct web pages that can be viewed across a variety of platforms and browsers. The class will also help students understand the constraints and advantages of working with the web as compared to traditional print media. Upon completion, students will be capable of designing, creating, and launching their own web sites. Your own laptop is required, with the following software installed: Photoshop, Illustrator, Dreamweaver, Flash. This course is for Design Majors only, or by special permission of the instructor.

51-330 Photo Book Design

Intermittent: 9 units

The Photo Book Photographs are often made into books. In this course, students will make photographs with the intention of presenting them as a book. We will deal with theme and content, image sequence and size, and the use of text with image. In addition to making their own, students will look at historical and contemporary photo books to see how the rich tradition of photo book has evolved through time and continues today. For Communication Design majors, or by the permission of the instructor. Extensive shooting and darkroom work, library research. Prerequisite: college level photography course.

51-331 Advanced Calligraphy I

All Semesters: 9 units

Continued study in the discipline of calligraphy. (Meets with Introduction to Calligraphy I.) Two directions may be taken. (1) Enlarging the student's repertoire of scripts, contemporary or traditional, for use in limited areas of work such as book or display work. (2) Concentrating on more intensive problem solving using a limited repertoire of scripts such as Roman, Italic, Sans Serif. Prerequisites: 51232

51-332 Advanced Calligraphy II

All Semesters: 9 units

Continued study in the discipline of calligraphy. (Meets with Introduction to Calligraphy II.) Advanced problems or new direction determined by student and instructor. Prerequisites: 51331

51-334 Type and the Package

Intermittent: 9 units

The package is a unique structure designed to protect a product from its point of manufacture to the point of purchase. Its product semantics are intended to provide a sense of its contents through its design as well as through the messages on the packaging surfaces, (ie package and/or box). This course will explore the

package from its structural design/product semantics as well as the typographic messages used to communicate the product to the buyer/user. We will begin with some more fundamental products and concentrate on the product messages contained on them, their typographic and message representations on the packages. Here are some of the issues we will explore: type and its fit to branding, typography appropriateness, levels of simple to complex instructions on products, and effective typography for crowded shelf spaces. We will explore the typographic hierarchy of information on the package, play with the principle of "less type is more" and examine size levels of type on a package, and if there is time, there are still more explorations. The intent is to examine the effective role of typography in packaging. We will work with some established products as well as the potential of designing a package and its typographic content from the ground up. Instructor permission required for non-Design majors. Limit to 10 students: (because of the 2 hour class structure). I would like 5 CD and 5 ID students if possible as an ideal mix.

Prerequisites: 51301 or 51311

51-335 Mapping and Diagramming

Fall: 9 units

This course explores the different ways in which we communicate complex information, through maps and diagrams. Students will design maps and diagrams using subject matter of their choice. Instructor permission required for non-Design majors.

Prerequisites: 51301

51-338 Documentary Photography

Intermittent: 9 units

Documentary photography explores issues, often social, humanistic and/or political, in man-made culture. This course examines the work of many major nineteenth and through twenty-first century documentarians while students photographically investigate their own topics. Among the many ethical areas of a documentarian's concern, the course examines (through looking at the documentary tradition and through the student's own work) the following: the photographer's relationship to the subject; the choices involved in representing the subject; the act of selectivity in framing the subject; the reasons for making documentary photographs; the intended audience for documentary photography; and the appropriate final display of the photographs? Should they be on museum walls, are they effective as printed pieces, and are they accessible to and/or have the approval of the subject? Extensive shooting, printing, and library research. Prerequisite: A beginning photography course, or by the permission of the instructor.

51-341 How Things are Made

Fall: 9 units

This course introduces students to the alternatives of materials and manufacturing processes that are considered in product design and development. Through the combination of lecture, demonstrations and field trips students learn the advantages and disadvantages of various materials and processes, and how to choose and specify them in a particular product application. Required of ID students. Instructor permission required for non-ID majors.

51-342 Projects in Human-Centered Design

Spring: 9 units

This course presents an opportunity to experience and understand the human centered research and design process through a self-defined project. Projects follow a common sequence of exploratory human and product research, concept generation using participatory and co-design methods, and user feedback to evaluate emerging design concepts, as they are refined. Course format includes lecture, discussion, lab exercises, interim presentations, a final presentation and thorough documentation of the research and design process. Open to all juniors and seniors in Design. All others will be waitlisted and admitted by permission of the instructor.

51-343 Digitech Design Tools

Fall: 9 units

Digitech Design Tools This course is the application and experimentation of digital technology inputs and outputs. The purpose will be to design, build, and experiment with forms that are unique to computer controlled machining. The combination of 3-dimensional computer modeling and the dFab Lab facilities rapid prototyping equipment will provide the means and medium of primary output for project work. Studio and lab course structure. Instructor permission required for non-ID majors.

Prerequisites: 51243 or 51324

51-344 Advanced Digital Prototyping

Spring: Mini Session - 6 units

This course is an advanced course using SolidWorks computer modeling. It is a prerequisite for Production Prototyping.

Prerequisites: 51211

51-346 Production Prototyping

Spring: Mini Session - 6 units

This course is the 2nd half of Advanced Digital Prototyping, using your work in SolidWorks to produce hard models.

Prerequisites: 51311

51-349 Visual Notation, Journal

Intermittent: Mini Session - 4.5 units

This course is about keeping a daily visual journal. The importance of its use will be placed on ways of seeing, ordering, discovering and making relationships while involved in the process of visualizing, exploring and recording. We will use a variety of drawing media; some that may be new to you and through experimentation we'll look at the impact media has on your image making process. We will examine a variety of subjects both man made and natural, large and small. One major goal of the course is to have you see the journal as not just a compilation of notations but as a comprehensive tool for visual thought and expression. We will also examine journals done by a variety of designers, architects and artists and discuss how making visual assessments condition the way we think and see the world. Consistent with the credits given for this course a total of 5-6 hours of work, both in and out of class will be expected each week. Your journal will be turned in for evaluation the last day of class. Instructor permission required for non-Design majors.

51-350 Visualization

Intermittent: 9 units

This course introduces methodologies for visualizing, recording and presenting ideas. With an emphasis on creating visual narratives, students will 1. engage in activities of field notation, journaling, storyboarding, and "hot-house" conceptualization; 2. gain exposure to advanced rendering techniques using markers, chalk pastels, and adobe illustrator/photoshop; 3. appreciate the qualities and differences of idea, concept and presentation sketching; and 4. integrate these methodologies of visualization to develop a flexible structure for their design portfolios to communicate their body of work in a public forum. Roughly 8 weeks will be devoted to developing, drawing and illustrating ideas with the remainder of the semester focusing on presenting these ideas through portfolio construction. Instructor permission required for non-Design majors.

51-351 Drawing, Expression and Communication

Intermittent: Mini Session - 4.5 units

This course explores the use of drawing as a means of visualizing, communicating and expressing form, space and ideas and as such is seen as a fundamental activity used to develop visual thought in the design process. Weekly themes will be introduced, along with presentation and accompanying questions that require responses through the generation and development of work done primarily through freehand drawing. Specific conceptual and technical skills will be discussed both individually and in groups with emphasis placed on individual interpretation and exploration of the assignments with the goal of developing visual fluency. A part of the course will be spent looking at how designers have used drawing in the design process at various times through history and within a variety of contexts. Emphasis is placed on draftsmanship and more on the role drawing may play in the complex process of visual thinking and notation. Consistent with the credits allocated to this course a total of 5 hours of work, both in and outside of class, will be expected each week. A portfolio of work will be expected the last day of class. Instructor permission required for non-Design majors.

51-353 Writing & Photography: Magazine Writing & Journalism

Intermittent: 9 units

Revealing Place: Photographers and Writers Working Together Writers and photographers have worked together throughout the 20'th and into the 21'st century to produce powerful documents. We are interested in how photographs and words describe people and places, and the dialogue that happens when words and images come together. Students will work individually and in teams, doing field research in the community as photographers and writers. Students will respond to a variety of short assignments along with a semester-long project. Course is open to Design and English juniors, seniors and grad students by instructor's permission

51-371 Learning to Look

Intermittent: Mini Session - 4.5 units

Topics courses address important themes in the history, theory, and criticism of design. Offerings vary from year to year. Lectures and discussions. Extensive readings. No prerequisites.

51-374 Understanding Perception through Design

Intermittent: 9 units

This course emphasizes audience expectations, also known as schemas, as a major influence on the artifacts we produce. For example, we read marble Corinthian columns as an entrance to a courthouse rather than to a home. The manner we use to communicate, either following or deviating from expectations, affects the way people perceive and process the information we present. Through lectures, discussions, readings, and projects, we will study the use of schemas in both print and digital mediums. We will also explore the bearing of expectations on the types of interactions and experiences we produce, answering the question: Can information become concrete and experiential versus abstract and readerly? Instructor permission required for non-Design majors. Prerequisites: 51301 or 51311

51-376 Aesthetics and Design

Intermittent: 9 units

The course will explore the principles of visual composition, proportioning systems and the rules of order as it relates to art, architecture and design. The class will involve extensive reading and discussion of these topics in class. Some project work will also be required but minimal to the reading. A reading list will be provided. Instructor permission required for non-Design majors.

51-378 History of the Book and Printing

Intermittent: Mini Session - 6 units

A survey of the materials and techniques used to make books covering manuscripts, calligraphy, printing, presses, type design, readers, illustrators, graphic techniques, and even e-books examined using a variety of tools: real rare books, readings, discussion, in-class exercises, essays & quizzes.

51-380 Rise in Consumerism

Intermittent: 9 units

This interdisciplinary course will explore the historical literature and cultural representations of 150 years of American consumer culture, with cross-cultural references. By the mid-19th century, the relationship between production and consumption had shortened the life cycle of many commodities. Urbanization and industrialization changed our relationship to the material world as social, cultural and economic forces transformed producers to consumers. Students will examine design through primary and secondary sources to trace the development of department stores and shopping malls, advertising and brand management, distribution mechanisms from mail order catalogues to ebay. Additionally, broader cultural representations will highlight changes in gender perceptions about consumption in art, literature, and film, including excerpts from *The Gay Shoe Clerk* (1903), *The Women* (1939), *I Can Get it for You Wholesale* (1951), *Clerks* (1994), and *Shopgirl* (2005). Short stories—O. Henry's *The Trimmed Lamp* <http://historymatters.gmu.edu/d/5021/>

51-383 Conceptual Models

Intermittent: Mini Session - 4.5 units

The challenge in human-centered design is not in conducting appropriate research, but in making the leap from research findings to design implications. Creating a model is often an important step toward creating consensus or a driving concept when working with multidisciplinary development teams. In this mini we will focus on one of the most challenging aspects of the design process. We will quickly develop a "hunt statement", conduct discovery stage immersive research and use our findings to develop conceptual models and design implications. This course is open to upper level students in Design, HCI, BHA, engineering and graduate business students.

51-385 Designing for Service

Intermittent: 9 units

As the service sector continues to dominate the US economy, companies will turn to design thinking to address the opportunities and challenges faced by the shift to a knowledge-based service-centered society. In the past, services have rarely been consciously designed, and when they have, they've looked back toward product design for inspiration. In this mini we will look forward toward designing for service in ways that stimulate senses, connect deeply with people's lifestyles, emphasize the broader social and cultural context of people's actions and provide support through a networked "service ecology". This course is open to upper level students in Design, HCI, BHA, engineering and graduate business students.

51-387 Information and Interaction

Intermittent: Mini Session - 4.5 units

Despite recent technological advancements, the representations of dense bodies of information still overwhelm viewers by requiring them to spend lots of time and energy deciphering content, while providing them little feedback on their accomplishments. Designers often give viewers a few options for organizing information. However, the content frequently remains fixed, enabling little input from viewers. In this class we will investigate the use of visuals, sound, and motion as tools for representing information that engages viewers in enjoyable, participatory processes of exploration and discovery. Throughout the mini we will explore dynamic information design from the viewer's perspective by discussing their desires and expectations. We will explore strategies for developing appropriate representations of content, the value of patterns to deciphering the meaning of information, the importance and structure of entry points, and the role of interaction in setting the stage for fulfilling experiences. Instructor permission required for non-Design majors.

51-392 Beyond the Snapshot - using Photography to see, to think, to feel

Intermittent: Mini Session - 4.5 units

No one doubts the value of photography as a means of recording life. Even if we don't think of ourselves as photographers, digital cameras make it easy to photograph our families, our trips, and aspects of our life that we want to remember. But beyond snapshots, can photography also teach us how to see? Does looking through the camera's viewfinder sensitize us to world and help us see more? Or, as some writers suggest, does the camera interfere with experiencing the world fully. This mini explores seeing with the camera and the many issues that arise when one snaps the shutter. In addition, we will be looking at a range of different kinds of photographic images and understanding how to read them. While we are making photographs, we will be discussing critical issues in photography that come out of significant readings by Susan Sontag, Roland Barthes, and others. We will break the course into three main subject categories—photographs of people; photographs of the social and man-made landscape; and photographs that are art driven. By using these subjects, students will become better seers in the world, more critical of images generally and of their own images; and, they will become more aware of the photography as an expressive medium. Prerequisite: A college level photography course 15 students—junior to grad Familiarity with digital photography and a digital camera

51-394 Applied Research Methods

Intermittent: 9 units

Applied Research Methods is a lecture course that explores a range of research methods from traditional behavioral research to contemporary methods in use today. The goal of the course is to understand the process that the designer employs to understand the 'say, do, make' responses of the user in order to develop appropriate solutions. We will look at a variety of methods for gathering qualitative information that inform the concept stages of the design process such as questionnaires, interviews, observations, trace measures, action research/participatory research methods. Starting out with simple exercises, we will progress to multi-method approaches for tackling more complex design problems. Pre-req: Design major status, or permission of the instructor. This course number is intended for juniors and seniors.

51-396 Information Design for Mobile Interface

Intermittent: Mini Session - 4.5 units

Throughout human history, the ways of representing information changed as the technology of communication medium developed. one of the important directions of current technology is mobility. However, this raises an interesting design problem. Mobile devices tend to have smaller screens, which is a challenge for displaying complex visual information. Students will be encouraged to explore methodologies for presenting verbal and visual information in a mobile interface. This can encompass a broad range of mobile media such as mobile devices, augmented reality, car dashboards, etc. This course will introduce design principles, practical issues, and working examples of information design for mobile interface. Students will be required to create two individual project assignments regarding time and space. No programming skills are required. Design majors only, or permission of the instructor - juniors, seniors or grads.

51-398 Methodology of Visualization

Intermittent: Mini Session - 4.5 units

For ID and CD students who have taken First Year drawing Limit 12 students This mini-course will focus on field sketching, notation and rapid visualization in context. Over the course of 7 weeks, students will use various field excursions, exercises, and projects to develop competencies in perspective drawing, visual narratives,

basic rendering, and figure drawing. The subject matter will vary, yet all lead towards generating communicative drawn artifacts. The primary project for this course will be a filled sketchbook.

51-399 Junior Independent Study

All Semesters: 3-12 units

Guidelines for independent study in the Design office. Proposals must be approved by faculty before registration.

51-403 Senior Project: Interaction Design

Fall: 12 units

The senior year offers Design majors the opportunity to explore a variety of advanced topics through project-oriented courses. These project courses typically require an integration of skills and knowledge gained throughout the entire design program. Senior projects are often funded by outside companies or organizations, providing real world clients. This project highlights the role that visual interface designers play in the multi-disciplinary attempt to bridge the gap between functionality and usability and to introduce students to some of the unique challenges of designing within the realm of a digital, interactive medium.

51-404 Senior Project: Interaction Design

Spring: 12 units

This is the spring offering of 51-403.

51-405 Senior Project: Communication Design

Fall: 12 units

The senior year offers Design majors the opportunity to explore a variety of advanced topics through project-oriented courses. These project courses typically require an integration of skills and knowledge gained throughout the entire design program. Senior projects are often funded by outside companies or organizations, providing real world clients. This project varies from one semester to the next, providing various opportunities in areas such as exhibit design, branding, and web design.

51-406 Senior Project: Communication Design

Spring: 12 units

This is the spring offering of 51-405

51-407 Senior Project: Product Design

Fall: 12 units

The senior year offers Design majors the opportunity to explore a variety of advanced topics through project-oriented courses. These project courses typically require an integration of skills and knowledge gained throughout the entire design program. Senior projects are often funded by outside companies or organizations, providing real world clients. This project focuses on new product development.

51-408 Senior Project: Environmental Design

Spring: 12 units

This is the spring offering of 51-409

51-409 Senior Project: Environmental Design

Fall: 12 units

The senior year offers Design majors the opportunity to explore a variety of advanced topics through project-oriented courses. These project courses typically require an integration of skills and knowledge gained throughout the entire design program. Senior projects are often funded by outside companies or organizations, providing real world clients. This project involves the design of a space, both indoors and outdoors, navigation of the space, and use of the space. Projects could include signage, exhibit design, navigation and wayfinding, furnishings within a space, or even park design.

51-414 Senior Project Integrated Product Development

Spring: 12 units

This course provides an integrated perspective on the many processes by which new products are designed, manufactured, and marketed. Under the direction of faculty from Design, Engineering, and Industrial Administration, students will work together in interdisciplinary groups on the development of real products. In addition to the product development project, the course includes lectures on innovation strategy, opportunity identification, designing products, object representation and manufacturability rules, computer-assisted design and prototyping, concept testing and protocol analysis, redesign issues, market testing, manufacturing and production, and product introduction and management. Open to graduate and senior-level engineering students, industrial administration students, and design students.

51-421 Basic Interaction

Fall: 9 units

This course highlights the role that visual interface designers play in the multi-disciplinary attempt to bridge the gap between functionality and usability and to introduce students to some of the unique challenges of designing within the realm of a digital, interactive medium.

51-422 Basic Interaction

Spring: 9 units

Intended for HCI double majors, this is the spring offering of 51-421 Introduction to visual interface design. This course highlights the role that visual interface designers play in the multi-disciplinary attempt to bridge the gap between functionality and usability and to introduce students to some of the unique challenges of designing within the realm of a digital, interactive medium.

51-423 Introduction Computing in Design

Fall: 9 units

This digital studio/seminar course introduces fundamentals of computing that are important for designing digital media. Initially, basic concepts of the computing environment, such as display technologies, input/output devices, networks, and software, are introduced. Students are then introduced to various computational concepts through hands-on programming exercises. Recent programs include Java, Flash, and Action Script. No prior programming experience is required. Prerequisite: concurrent registration in Graduate Design Seminar I and Graduate Studio I or approval of instructor. This course also requires a laptop computer for completing in-class exercises.

51-425 Letterpress and Bookbinding

Fall and Spring: 6-9 units

Concerning the Lab Class 51425 & 51426 (beginning) Bookbinding and Letterpress. This is listed as variable units, but one must elect 6 or 9 units and the maximum is 9 units. REGISTRATION INFO: If one is interested in registering for this Lab Class this is what needs to be considered: You will need to reserve, in your academic schedule, either three, or six hours a week to meet for lab class. If your semester schedule allows for 6 hours, then you elect 9 units. If one can only fit in 3 hours, then 6 units is elected. The day, or days, and times are then scheduled with me at the start of the semester. If you are registered, or if you have contacted me, I will be able to email you as to when an orientation meeting is to be held. LAB CLASS CONTENT: Usually there are three binding projects relating to basic book and box structures. We also work on one small hand typesetting & letterpress printing project of a basic nature to gain an experience with hand setting type, form building, letterpress printing and hand press operation. Normally the above project work is completed by mid-term, and for the remainder of the semester we hand set and print a small edition project. This is the total Lab Class semester experience for 6 units. Those who register 9 units are required to plan a personal project, and this is in addition to the assigned projects. A Mini Class may be possible, through Individual Project, which should be valued at 3 units. See instructor, Joe Dicey, about this.

51-427 Time Motion and Communication

Intermittent: 9 units

In the digital medium, we are no longer limited to static forms for expressing information. This digital studio course explores the use of kinetic forms - visual forms expressed over time - to understand their unique qualities in communication design.

51-433 Advanced Interaction

Intermittent: 9 units

An interface is the link between a user and a product that communicates how a product will be used and creates an experience for the people who will use it. Interaction design is the process of creating and defining product behavior, encompassing both usability and aesthetic dimensions of an artifact, service, or environment. In this course, we will explore issues that pertain to the design of interfaces that activate vision, hearing and touch, with a focus on a variety of design principles, information hierarchy and navigation, multi-modal information presentation, user-product interactions, and how these elements become part of a larger design process. Students will develop a process for creating interface designs that can be reapplied in future contexts. Prerequisites: 51421

51-434 Experimental Form

Intermittent: 9 units

Experimental Form Studio This course looks at the way objects elicit emotional responses and play key roles in enhancing our daily lives. The 5 individual themed projects for the semester, found, formed, fabricated, fiber, and functional, incorporate various

production processes with traditional and new (sustainable) materials, emphasize different form-making principles, and lead to artifacts whose forms richly communicate on both visual and deeper emotional levels. Artifacts generated in this course can be identified as sculptural objects or functional art and be highly graphic in their visual presentation. On the last day of the semester, we will open a 2 week long gallery show in 5 different locations on campus and in street-side window displays along Butler Street in the 16:62 Design Zone in Lawrenceville.

Prerequisite: Junior standing in ID. Limit: 15 students

51-441 Product Planning & Development

Fall: Mini Session - 4.5 units

Product Planning and Development The course will explore examples of case studies of product planning strategy from several levels. The first level will explore how companies establish brand strategies and determine the markets that they want to compete in. The second level will look at how companies develop overall product lines that express corporate brand and then also connect with consumers in product markets. The third level is the planning of specific product programs. The course will begin as a seminar discussion of case studies and evolve into team research on the development of a product strategy using an actual company's brand identity. This course is for seniors or graduate students in design, BHA and engineering, and graduate business students.

51-451 Fundamentals of Joinery & Furniture Design

Fall: 9 units

Intensive introduction to traditional joinery techniques and the properties of wood through the use of textbook studies and lab experiments. Emphasis placed on how these techniques and properties influence design decisions. Students will learn how to set up, sharpen and use traditional hand powered tools. This acquired knowledge will be applied in the design and realization of a piece of wooden furniture. Limited enrollment. Lab fee and material purchases required.

Prerequisites: 51243

51-452 Furniture Design II

Spring: 9 units

A continuation of 51-451, this course explores a much broader range of issues related to furniture design. Students will identify and define in a proposal the area of furniture design they intend to investigate and then produce one or more furniture pieces developed from their findings. Materials and processes applied to the project are limited only by the resources the student can bring to bear. Assigned readings and a series of in-class discussions will focus on the influence of workmanship in design, and on how the behavior of the user is influenced by the form or esthetic language of the artifact. Lab fee & material purchases required.

Prerequisites: 51451

51-453 Applied User Research

Mini Session - 4.5 units

This course is an opportunity for students to study how user research applies to concrete design projects in an organizational context. We will study three different design projects that pursue a human-centered design approach: The Domestic Mail Manual (DMM) Transformation Project by the United States Postal Service, the Australian Taxation Project by the Australian Tax Office, and the Income Tax Form Redesign by the Internal Revenue Service of the United States. Students will trace the role of user research in each case. The class will take the format of a seminar with lectures, presentations and readings. Together with actual samples from the three case studies, they will provide a background for rich discussions. Students will walk away with three key insights into applied user research: They will understand how user research applies to a complex system, such as an organization. Simultaneously, students will gain an understanding of the opportunities and the potential pitfalls that arise when co-designing with a client. Finally, by studying the design process and the artifacts that were developed by these three projects, the contribution of user research in designing interactions of individuals with organizations, the effect of user research on an organization and the role of user research organizational change will become evident. Open to graduate and advanced undergraduate students in design. Because of the nature of the projects and the organizations involved, this course may also be of interest to students with a background in organizational behavior, management and public policy.

51-471 Practicing Design

Fall: 9 units

This is a lecture course covering all aspects of design practice. Students learn to formulate a plan for professional practice, market creative services, manage projects, and understand the legal and ethical issues associated with design practice. This course will also address the changing role of the design professions. Visiting professionals, case studies, and supplementary readings provide resources for class discussion. This course is required for all senior design majors.

51-472 Globalization and Design

Intermittent: Mini Session - 4.5 units

Designers are often required to plan products for markets around the world. Diversity of cultural value plays a central role in user experience and product development in the global context. This mini course is a seminar that explores the topic of culture. The first part of the course will provide students with terminology, perspectives, concepts, and knowledge based on discussions of selected readings from the classic and contemporary literature as well as diverse examples from the field. The second part of the course will examine how these theories relate to design research and practice. Individual and group assignments will help students relate the concepts to the practice of design. Pre-req: Design major or minor status; juniors and seniors only.

51-479 Design Methods: Analysis and Creativity

Intermittent: 9 units

Design Methods: Analysis and Creativity Most designers recognize that "process" is an important part of professional practice, yet the "methods" that try to capture design process are varied and often conflicting. The goal of this course is to explore design methods and their supporting techniques, seeking a better understanding of the pattern of inquiry upon which they are based. The course will include a close reading of works in the "design methods movement" of the 1960s and 1970s. This movement rightly occupies a central place in the development of design methods and methodology in the twentieth century. It is at times insightful, at other times confusing and dissatisfying. Nonetheless, it is essential to understand what was attempted and actually accomplished by individuals such as Bruce Archer, John Chris Jones, Horst Rittel, and Christopher Alexander. Our current understanding of design methods, including the new forms of user research, is grounded on their work.

51-481 Visualizing Stories

Intermittent: Mini Session - 4.5 units

Students This course is open to HCI and Design graduate students and senior-level Design students. Students need a basic knowledge of communication and interaction design. Experience with interactive prototyping, digital video editing, and graphic layout are encouraged but not required. Course Description When viewers watch a TV news story, they never see the whole story. Instead they see, a short synopsis of the back-story, a quick update of the latest findings, and speculations on the future outcome. Will he be found guilty? Will she be re-elected? Will the hurricane damage more property than last time? What viewers never get from TV news is a complete view of how a story evolves over time from beginning to end. In this project course students will work in small teams to develop visualizations of both individual current news stories as well as the evolution of these stories over time. Working with a small set of CNN video clips, students will produce both static and interactive visualizations that offer insights into the story that a traditional linear video broadcast can never provide. In much the same way Minard's map on Napoleon's march to Moscow captures an entire story in a single image, students will work to reveal the relevant features that best communicate both what is happening in the individual news story as well as the larger story evolving over many weeks.

51-488 Design, Management and Organizational Change

Intermittent: 9 units

Design, Management, and Organizational Behavior 51-488/51-788 The goal of this course is to help Design students better understand how organizations affect the practice of design and, in turn, how the practice of design and affect organizational life. Topics covered will include the history and theory of management, some of the current practices of management that have direct bearing on design (such as strategic planning), and some of the central concepts of organizational theory that will help students learn to interpret and work within organizations. Pre-requisites: this course is intended primarily for design graduate students, with a few seats reserved for undergraduate Design majors. Non-Design majors must obtain the instructor's permission to register for this course.

51-499 Senior Independent Study

All Semesters: 3-12 units

Guidelines for independent study in the Design Office. Proposals must be approved by faculty before pre-registration.

Entertainment Technology Pittsburgh**53-800 Introduction to Maya**

Summer: Mini Session - 12 units

This is an introductory class for Alias|Wavefront's Maya 4.0.

Students will master the complex interface and toolset of Maya. Introduction to Maya will concentrate primarily on the proficiency of use for the tool, and secondarily on the sharpening of personal skill sets such as modeling and animating. There will be in-depth discussion of the basic paradigms and methodologies use in all leading 3D modeling packages for a better understanding of how Maya and other 3D applications work internally. Students will be assigned small-scope projects in modeling, animating, texturing, and lighting. Most of the features discussed will be geared towards current game industry use. Specific features covered include... Low-poly modeling High-poly modeling Character modeling Bones NURBS UV Mapping Mechanical Animation Character Animation ...and may include... MEL Scripting Dynamics (Physics) Lighting (Including Radiosity) Who should apply: Students who want to learn how to use all of the features of Maya 4.0. This is an intro course. No prior knowledge of any 3D software is required.

53-887 Virtual Presence: Art and Applications

Spring: 12 units

Virtual Presence: Art and Applications is an interdisciplinary graduate-level seminar exploring the use of interactive virtual representations of real places (i.e., the Earth, Pittsburgh, etc.) for educating, engaging, motivating, and/or serving segments of the public. This class will be an extension of the previously taught Telepresence: Art and Applications class. Details: The Carnegie Mellon University Remote Experience and Learning Lab, developer of the EventScope remote experience software, invites students into the lab to learn about virtual presence and participate in the development of new experiences. Software such as EventScope and Google's recently released Google Earth highlight the coming of sophisticated, 3D applications that display satellite data for the public.

Drama**54-101 Acting I**

Fall: 9 units

A knowledge and beginning understanding of the components of acting. Basic exercises, improvisations and prepared work in relaxation, concentration, imagination, communication. The ability to create the reality of a given situation in theatrical terms. Craft fundamentals in preparation for scene study. The beginning development of the students creative resources.

54-102 Acting I

Spring: 10 units

A knowledge and beginning understanding of the components of acting. Basic exercises, improvisations and prepared work in relaxation, concentration, imagination, communication. The ability to create the reality of a given situation in theatrical terms. Craft fundamentals in preparation for scene study. The beginning development of the students creative resources. This course is open to Drama majors only.
Prerequisites: 54101

54-103 Speech I

Fall: 6 units

(Speech & Phonetics) The course introduces students to the pronunciation of the sounds of the Standard American English Dialect. The International Phonetic Alphabet (IPA) is used to teach the students a symbol for each vowel, diphthong and consonant sound of the dialect. This process will strengthen the student's production of the thirty-nine sounds and will eliminate regional characteristics. Intonational patterns of the dialect are also studied and practiced. The work is applied to weekly presentations of poetic texts. Phonetic transcription is required of class participants from the beginning of this course.

54-104 Speech I

Spring: 6 units

(Speech and Phonetics) The second semester is a continued investigation and drill of the thirty-nine sounds of the Standard American English Dialect as well as the music of the dialect.

Students apply the principles of the five degrees of stress of the dialect, inflections and intonational patterns and the use of the weak forms of certain parts of speech of the English language to the weekly presentations. The last four weeks of this semester are focused on preparation for a public performance of each student's favorite poet's poetry, all of which is memorized and transcribed phonetically.

54-105 Voice/Alexander I

Fall: 5 units

Voice 1 Fall Voice 1 covers the introduction to voice training based on the Linklater voice work as well as other techniques. Students will learn basic warm ups, identification of healthy voice use and application of voice work to acting work, based on Michael Shurtleff THE AUDITION. Required Text FREEING THE NATURAL VOICE, second edition by Kristin Linklater. Time permitting some basic introductory work to the Alexander Technique will be covered.

54-106 Voice/Alexander I

Spring: 6 units

Voice 1 Spring (prerequisite Voice 1 fall) A continuation of Voice 1 introducing the exploration of resonators,(resonex ®), Shakespeare and personal writing. Students will develop a basic daily vocal practice and learn how to lead a basic warm up. Time permitting, continuation of introductory Alexander work.

54-107 Movement I

Fall: 4 units

This course serves as a foundation for all future movement studies. Kinesthetic awareness and responsiveness is developed through the introduction of the Viewpoints method of physical training. The importance of physical expressivity and specificity in storytelling is achieved by the creation of physical movement based compositions. This is a required course for all first year undergraduate Acting and Musical Theatre and Directing students. Other students may register for this course only with the instructor's permission.

54-108 Movement I

Spring: 4 units

Prerequisite: 54-107 or permission of the instructor. This course focuses on the ability to make physically specific choices in order to convey character through an introduction to the basic principles of Laban Movement Analysis and further work in the Viewpoints method of actor training. This course is required for all first year undergraduate Acting and Musical Theatre majors

54-109 Dramaturgy I

Fall: 9, 15 units

This class introduces the art and science of production dramaturgy, emphasizing the history of world theatre from a dramaturgical perspective, a broad grounding in critical theory of drama, and skill-building exercises in research, presentation, and writing. Freshmen dramaturgs must either take this class or Dramaturgy II along with Crew for an additional 6 credits.

54-110 Text

Fall: Mini Session - 3 units

This class is in conjunction with Acting I in the School of Drama. The actor/director learns how to investigate the written text and translates it actively for performance.

54-111 Text for Actors

Spring: Mini Session - 2 units

This class is in conjunction with Acting I in the School of Drama. The actor/director learns how to investigate the written text and translates it actively for performance.

54-121 Directing I: Sources

Fall: 9 units

An interdisciplinary exploration of the directors art through the study of modern art movements. Students will be required to do extensive research on one specific movement i.e. Surrealism or abstract expressionism, and create a performance piece based on the visual and social elements of that particular movement.

54-122 Directing I: Sources

Spring: 9 units

A continuation of the previous semester focusing on Music and Dance of the twentieth century and how they influence the directors art.
Prerequisites: 54121

54-123 Ballet I

Fall: 5 units

This course uses Classical technique (Ballet) to build body placement, alignment and muscular strength and flexibility.

Designed to help the student develop a way of learning how to work and train for any dance form. This technique is the basis of the choreography in American musical theater. Course closed: Only for Music Theatre majors in Drama. Prerequisite: Permission of instructor

54-124 Ballet I

Spring: 5 units

This course continues Classical technique (Ballet) to build body placement, alignment and muscular strength and flexibility. Designed to help the student develop a way of learning how to work and train for any dance form. This technique is the basis of the choreography in American musical theater. Course closed: Only for Music Theatre majors in Drama. Prerequisite: 54-123 and Permission of instructor

54-125 Music Skills I

Fall: 2 units

The students explore the basics of music theory, which includes intervals, rhythm, notation and musical vocabulary. Emphasis is on acquiring these basic skills through sight singing.

54-126 Music Skills II

Spring: 2 units

The students explore the basics of music theory, which includes intervals, rhythm, notation and musical vocabulary. Emphasis is on acquiring these basic skills through sight singing.

54-151 Stagecraft

Fall: 15 units

The stagecraft class is designed to provide an introductory level of technical training in all the theatrical technical disciplines over the course of two semesters. The intent is to produce people who can capably fill roles on production crews and perhaps serve as an assistant to the head of the crew. Course content will cover materials, tools & equipment, procedures, safety and operations for Carpentry, Props, Paints, Metals, Costumes, Lights, Sound, Rigging, and Run Crew. As well as providing opportunity and experience to grow as technicians, this content will also help establish a foundation to begin the process of becoming managers and designers. As craft skills are often best communicated in a master/apprentice environment this course is set up as a mentored practical experience. This course will require additional time during the evening and on weekends.

54-152 Stagecraft

Spring: 11 units

The stagecraft class is designed to provide an introductory level of technical training in all the theatrical technical disciplines over the course of two semesters. The intent is to produce people who can capably fill roles on production crews and perhaps serve as an assistant to the head of the crew. Course content will cover materials, tools & equipment, procedures, safety and operations for Carpentry, Props, Paints, Metals, Costumes, Lights, Sound, and Rigging. As well as providing opportunity and experience to grow as technicians, this content will also help establish a foundation to begin the process of becoming managers and designers. As craft skills are often best communicated in a master/apprentice environment this course is set up as a mentored practical experience. This course will require additional time during the evening and on weekends.

54-157 Basic PTM

Fall: 6 units

Students in the Basic PTM course are exposed to the very fundamentals, the primitives, of entertainment technology. The intent is to provide the absolutely strongest beginning for all the work to come, to provide a solid foundation for students and instructors to build upon. Production professionals routinely perform organizational tasks. In order to be able to meet that challenge, students will need to build a toolkit of information and procedures. That toolkit will be comprised of knowledge of the kinds of parameters and techniques that are normally selected, the indices that parameters and techniques are evaluated against, and many of the wide range of issues that might point a manager toward one decision or another. There also exists an entire pantheon of information that people typically learn "on the job." Activities and information presented in this course are designed to try to expose students to as much of this on the job type development as possible with the goal of leapfrogging them past the bottom rung of the workplace ladder.

54-158 Basic PTM

Spring: 6 units

Students in the Basic PTM course are exposed to the very fundamentals, the primitives, of entertainment technology. The intent is to provide the absolutely strongest beginning for all the work to come, to provide a solid foundation for students and instructors to build upon. Production professionals routinely perform organizational tasks. In order to be able to meet that challenge, students will need to build a toolkit of information and procedures. That toolkit will be comprised of knowledge of the kinds of parameters and techniques that are normally selected, the indices that parameters and techniques are evaluated against, and many of the wide range of issues that might point a manager toward one decision or another. There also exists an entire pantheon of information that people typically learn "on the job." Activities and information presented in this course are designed to try to expose students to as much of this on the job type development as possible with the goal of leapfrogging them past the bottom rung of the workplace ladder.

54-159 Production Symposium I

Fall: 6 units

Hands on experience in most aspects of building and running a production.

54-160 Production Symposium I

Spring: 6 units

Hands on experience in most aspects of building and running a production.

54-162 Intro to Costume Design

Spring: 6-21 units

Basic Introduction and practice, through preparation and crew assignments, in building and handling scenery, costumes, props, and lighting.

54-163 Production for Non Majors

Fall: 6 units

Basic Introduction and practice for non-majors, through preparation and crew assignments, in building and handling scenery, costumes, props, and lighting. Special Permission required to take this course.

54-164 Production for Non Majors

Spring: 6 units

Basic Introduction and practice for non-majors, through preparation and crew assignments, in building and handling scenery, costumes, props, and lighting. Special Permission required to take this course. Prerequisites: 54163

54-166 Introduction to Sound Design for Theatre

Spring: 6-21 units

Students explore the basic principles and theories of sound design from technical, psychological and aesthetic standpoints. Course work includes instruction in the controllable properties of sound, practical planning of sound plots, cue creation, and the design process. Prerequisite: 54-231 Design For The Stage

54-169 Studiocraft

Fall: 13 units

The studiocraft course provides beginning level instruction in Drawing, Hand Drafting, and CAD Drafting.

54-170 Studiocraft

Spring: 8 units

The studiocraft course provides beginning level instruction in Drawing, Hand Drafting, and CAD Drafting.

54-171 Basic Design

Fall: 6 units

A year-long studio course exploring the principles and elements of design and research in discreet exercises and projects first semester. Second semester focuses on the theatrical design process and each of the disciplines with projects in scene, costume, lighting, and sound design as well as a strong component in drawing. Reports throughout the year expose the students to designers theatres and artists of note in the world. This section is concurrent with Drafting and Figure Drawing sections. Prerequisite: Declared Design/PTM focus in the School of Drama For: First Year Undergraduate Students

54-172 Basic Design

Spring: 6 units

A year-long studio course exploring the principles and elements of design and research in discreet exercises and projects first semester. Second semester focuses on the theatrical design process

and each of the disciplines with projects in scene, costume, lighting, and sound design as well as a strong component in drawing. Reports throughout the year expose the students to designers theatres and artists of note in the world. This section is concurrent with Drafting and Figure Drawing sections.

Prerequisite: Declared Design/PTM focus in the School of Drama
For: First Year Undergraduate Students

54-177 Foundations of Drama I

Fall: 6 units

The Foundations of Drama sequence is a three-semester program that develops the ability to read, understand, and write critically about plays and performances, from a variety of critical perspectives, as an essential step in preparation of an artistic product. In Foundations I and II, the student will learn various techniques for "close reading" and in-depth critical analysis of plays from a wide variety of historical and cultural contexts, and within different theoretical models of interpretation. These courses place a heavy emphasis on research, writing, the critical use of evidence, and the practical application of all three into the creation of a living, breathing performance. The third semester is a required 9-hour H&SS course that has been pre-approved by the Professors. Upon successful completion of Foundations I (6 units, meets in two 1:20 sessions per week), the student will have a basic command of the following practitioner skills: close reading and script analysis; critical writing about dramatic literature; and basic dramaturgical research and application.

54-178 Foundations of Drama II

Spring: 6 units

Upon successful completion of Foundations II, the student have refined the basic skills of F-I and also will be able to : demonstrate a broad knowledge of important dramatic literature from Greeks to present day (including nonwestern); research and discuss in a class setting significant elements of plays; understand and apply the concept of "Circles of Knowledge" when dealing with page-to-stage research; and write serious, interesting, and useful performance reviews.

Prerequisites: 54177

54-184 Dramaturgy II

Spring: 9 units

9 or 15 units This class continues the basic skill training of the dramaturgs with deepening work in critical theoretical training and deep research skills, culminating in the creation of a sample casebook. Freshmen dramaturgs must take either this class or Dramaturgy I along with Crew for an additional 6 credits.

54-187 Introduction to Playwriting

Fall: 9 units

Students will be introduced to the major components of writing for the stage, including dramatic action, character and dialogue. Exercises designed to familiarize students with the tools available to the playwright will be assigned each week. Readings of exercises and works-in-progress will take place on a weekly basis. In addition to reading each other's work, members of the class will also serve as the first test audience for your colleagues. Students will be expected to discuss their reaction to each exercise that is read. The final project for the course will be the completion of the first draft of a Ten-Minute play.

54-188 Introduction to Playwriting

Spring: 9 units

Students will be introduced to the major components of writing for the stage, including dramatic action, character and dialogue. Exercises designed to familiarize students with the tools available to the playwright will be assigned each week. Readings of exercises and works-in-progress will take place on a weekly basis. In addition to reading each other's work, members of the class will also serve as the first test audience for your colleagues. Students will be expected to discuss their reaction to each exercise that is read. The final project for the course will be the completion of the first draft of a Ten-Minute play.

54-189 Advanced Playwriting

Fall: 9 units

This course is intended to continue the process of familiarizing students with the basic components of dramatic writing, paying particular attention to the most basic building block of all effective plays -- dramatic action. We will also focus on the development of an effective structure for a one-act play, and on finding theatrical conventions which both suit the story and make it live on stage. In some cases, students may work on a long play with permission of

instructor. Readings will focus on contemporary plays that suggest effective alternative structures and unique uses of theatrical language. Prerequisites: 54187

54-190 Advanced Playwriting

Spring: 9 units

This course is intended to continue the process of familiarizing students with the basic components of dramatic writing, paying particular attention to the most basic building block of all effective plays -- dramatic action. We will also focus on the development of an effective structure for a one-act play, and on finding theatrical conventions which both suit the story and make it live on stage. In some cases, students may work on a long play with permission of instructor. Readings will focus on contemporary plays that suggest effective alternative structures and unique uses of theatrical language. Prerequisites: 54187

54-191 Acting for Non-Majors

Fall: 9 units

This class is designed for non-acting majors and introduces the student to the basic principles of acting, character study and improvisation. One semester course.

54-192 Acting for Non-Majors

Spring: 9 units

This class is designed for non-acting majors and introduces the student to the basic principles of acting, character study and improvisation. One semester course.

54-193 Introduction to Screenwriting

Fall: 9 units

This course is designed to introduce basic screenplay structure and formatting. Readings and films to see will be assigned. A short film or step-outline of a full length film are to be completed by the end of semester.

54-194 Introduction to Screenwriting

Spring: 9 units

This course is designed to introduce basic screenplay structure and formatting. Readings and films to see will be assigned. A short film or step-outline of a full length film are to be completed by the end of semester.

54-195 Advanced Screenwriting

Fall: 9 units

This course is designed to give writers a variety of tools they can use in writing or rewriting a current project full-length screenplay. There will films assigned to watch and analyze. Either a first draft or a rewritten version of a full length screenplay is to be completed by the end of the semester. By permission only.

54-196 Advanced Screenwriting

Spring: 9 units

This course is designed to give writers a variety of tools they can use in writing or rewriting a current project full-length screenplay. There will films assigned to watch and analyze. Either a first draft or a rewritten version of a full length screenplay is to be completed by the end of the semester. By permission only.

54-200 Ghost Light Forum

Fall and Spring: 1 units

Programmed and taught by senior students in the dramaturgy program, this course is required for all Dramaturgy Majors and meets once per week to discuss issues and topics of significance to the dramaturgy community.

54-201 Acting II

Fall: 12 units

Scene study: the fundamental techniques needed to participate in the developing conflict within the imaginary world. Character building through unfamiliar behavior and beliefs; relationships; language. Spring semester: The use of classical texts and ensemble playing. The deepening of the actors inner resources to be supported by the craft techniques. Prerequisites: 54101 and 54102

54-202 Acting II

Spring: 12 units

Scene study: the fundamental techniques needed to participate in the developing conflict within the imaginary world. Character building through unfamiliar behavior and beliefs; relationships; language. Spring semester: The use of classical texts and ensemble playing. The deepening of the actors inner resources to be supported by the craft techniques. Prerequisites: 54201

54-203 Voice and Speech II

Fall: 5 units

The actors take a more concentrated approach to elevated text. The course focuses on the effective production of classical text. The warm up sessions are geared towards preparing the student actors for the extravagant language from Shakespeare's plays and sonnets. Meter, imagery and further specific text work is also employed to encourage each student to find clear shape in the work. A repertoire of at least five classical monologues will come from the course work.

54-204 Voice and Speech II

Spring: 6 units

The actors take a more concentrated approach to elevated text. The course focuses on the effective production of classical text. The warm up sessions are geared towards preparing the student actors for the extravagant language from Shakespeare's plays and sonnets. Meter, imagery and further specific text work is also employed to encourage each student to find clear shape in the work. A repertoire of at least five classical monologues will come from the course work.

54-205 Ballet II

Fall: 3 units

This course is designed to build on the technical foundation, work habits and professional behavior established in Ballet I. The material presented expands the classical dance vocabulary to the next level of difficulty. Course closed: Only for Music Theatre majors in Drama. Prerequisite: Permission of instructor

54-206 Ballet II

Spring: 3 units

This course continues to build on the technical foundation, work habits and professional behavior established in Ballet I. The material presented expands the classical dance vocabulary to the next level of difficulty. Course closed: Only for Music Theatre majors in Drama. Prerequisite: 54-205 and Permission of instructor

54-207 Movement II

Fall: 3,5 units

This entire term focuses on the Neutral Mask, a completely non-verbal masked movement form, through which students search for a neutral base, both physically and psychologically, a place of complete presence in the present. The mask allows them to uncover all that is emotional in the body; the "baggage" carried from role to role, and provides techniques to free them from these limitations. Identifications with other forms of energy, the four elements, seasons, materials, colors and plant life give students new insights into the process of character development. The Neutral Mask work is immediately reinforced with applications to their scene work in Acting class. Prerequisites: 54107

54-208 Movement II

Spring: 3 units

This term is divided between two classic physical forms: Commedia dell'Arte and Clowns. In the first half of the semester students wear the half-masks of the archetypal Commedia characters (Harlequin, Pantalone, et al), to learn their psychology and physicality, improvise on historical and contemporary scenarios, and apply Commedia technique to modern comedy. Commedia dell'Arte gives them the tools to tackle physical comedy from any era, past or present. In the second half of the term students discover their personal Clowns. This clown has nothing to do with the American Barnum & Bailey Circus clown; this is not a character or caricature, but rather a revelation of the clown each student hides under the mask of adulthood. Discovering this clown gives them all a way to laugh at themselves, to uncover what makes each individual uniquely funny; it also lets them see how we only laugh at truth and in the personal material lies universal humor. Inside this freedom is the technique to know what's funny and why, and the ability to apply these rules in comedy. Prerequisites: 54108

54-211 Actor Dance II

Fall: 3 units

This course introduces the basic, fundamental vocabulary of Classical technique (Ballet) to train the body in proper alignment, placement, and muscular strength. Course closed: Only for Acting majors in Drama. Prerequisite: Permission of instructor

54-212 Actor Dance II

Spring: 3 units

A continuation of Classical technique (Ballet) and a unit of social dance styles, waltz, polka, foxtrot, tango, swing. Course closed: Only for Acting majors in Drama. Prerequisite: 54-211 and Permission of instructor

54-213 Singing for Actors II

Fall: 3 units

The students have a class voice experience which includes a physical and vocal warm-up and discussion and practice of healthy singing technique. There is group and individual rehearsal of potential audition and performance material. Toward the end of the term, there are weekly opportunities to perform in public, thus preparing for auditions.

54-214 Singing for Actors II

Spring: 3 units

The students have a class voice experience which includes a physical and vocal warm-up and discussion and practice of healthy singing technique. There is group and individual rehearsal of potential audition and performance material. Toward the end of the term, there are weekly opportunities to perform in public, thus preparing for auditions.

54-217 Jazz II

Fall: 2 units

This course is designed to incorporate the strength of classical dance technique to a jazz dance style. Training the body in a variety of contemporary Jazz styles, i.e. Latin, Blues, Lyric, African, using body isolations and rhythmic patterns. Course closed: Only for Music Theatre majors in Drama. Prerequisite: Permission of instructor

54-218 Jazz II

Spring: 2 units

This course continues to incorporate the strength of classical dance technique to a jazz dance Training the body in a variety of contemporary Jazz styles, i.e. Latin, Blues, Lyric, African, using body isolations and rhythmic patterns. Course closed: Only for Music Theatre majors in Drama. Prerequisite: 54-217 and Permission of instructor

54-219 Music Theatre Literature and Repertoire

Fall: 4 units

The students are exposed to many music scores of the basic choral and musical theatre literature. The students learn this repertory, reinforcing the principals of music theory learned in the first year.

54-221 Directing II: Fundamentals

Fall: 6,9 units

This is a Fall-semester course for 2nd-year students of all options introducing the fundamentals of the director's craft: text analysis; the work script with column method & blocking notation; determining the purpose of the writing; the concept of Action & Change (beats & transitions); practical use of the Six Aristotelian Elements of Drama; Genre & Style; the Dramatic Question; Levels in the Creative Process; Visual Vocabulary & Staging Tools including planes, levels, values of stage space, body positions; composition; picturization; emphasis; & movement; entrances & exits; the ground plan. Work includes unscripted exercises, then scripted exercises on an open stage & then within a detailed ground plan. Additional goals: to work in a professional manner; to value preparation, analysis & organization.

54-222 Directing II: Fundamentals

Spring: 9 units

A continuation of the work done in the first semester of Directing II. Limited to directing majors and BHA directors

54-223 Tap II

Fall: 2 units

This course trains the student to develop a comfort level to execute percussive sounds, in a variety of percussive rhythmic patterns while applying the technical foundation of alignment and placement from classical technique. Course closed: Only for Music Theatre majors in Drama. Prerequisite: Permission of instructor Prerequisites: 54123 and 54124

54-224 Tap II

Spring: 2 units

This course continues to technically train the student in a variety of percussive rhythmic patterns. Course closed: Only for Music Theatre majors in Drama. Prerequisite: 54-223 and Permission of instructor Prerequisites: 54223

54-226 Acting a Song

Spring: 4 units

Mines the personal life experience to bridge the gap between the Performer and the Song Lyric. Exercises are designed to break down internal blocks built by the expectation of Technical Perfection. The visceral is valued over the intellectual when approaching the Song Material. The students are exposed to groups of composers divided

into units including Gershwin, Porter, Rogers and Hammerstein, Bernstein, Coleman, Sondheim to the present composers. Each student prepares and performs the given songs and receives critique and instruction from each of the music and the acting teachers.

54-229 The Wolf's Colon

Fall: Mini Session - 6 units

Required for all Sophomore Design and Production students. Bring tools.

54-231 Design for the Stage

Fall: 6-9 units

This course is divided into four minis to introduce the student to the design process for costumes, lighting, scenery and sound.

Prerequisite: 54172

54-232 Design for the Stage

Spring: 9 units

This course deals with the fundamental needs and responsibilities of the scenic and costume designer. Emphasis is on the development of ideas based on a dramatic text. Students are asked to interpret a text and create a visual statement based on that interpretation through the design process. Studio work is included in the course work.

54-237 Scene Painting I

Fall: 6 units

This is a studio course in the foundations of scenic painting for theater and related fields. Students will complete projects that address the following topics: preparation of and paint techniques for both soft goods and hard covered surfaces, drawing and painting to scale, representing textures in both 2 and 3 dimensions, and color mixing. Subject matter changes often and may include: architecture, natural and man-made textures, drapery, interior/exterior scenes, human figure, still life objects.

54-238 Scene Painting I

Spring: 6 units

This is a studio course in the foundations of scenic painting for theater and related fields. Students will complete projects that address the following topics: preparation of and paint techniques for both soft goods and hard covered surfaces, drawing and painting to scale, representing textures in both 2 and 3 dimensions, and color mixing. Subject matter changes often and may include: architecture, natural and man-made textures, drapery, interior/exterior scenes, human figure, still life objects.

54-239 History of Architecture and Decor

Fall: 4,6 units

This slide/lecture course is a survey of architecture, interiors and furniture from ancient Egypt to the beginnings of the 20th Century.

54-240 History of Architecture and Decor

Spring: 4,6 units

This slide/lecture course is a survey of architecture, interiors and furniture from ancient Egypt to the beginnings of the 20th Century.

54-241 Improv Class

Fall: 4 units

This course for Sophomore Actors not only sharpens their skills as ensemble performers, but also allows for more playfulness, creativity and exploration, cultivating risk-taking and a certain abandon. Divided into two separate sections, the course concentrates on non-verbal, psychological improv to help the student actor achieve a kind of physical truth and spontaneity, while becoming aware of the importance of the body in conveying information; the second half is devoted entirely to comedy improv and may culminate in an original comedy improv show in the UC lobby.

54-242 Improvisation

Spring: 2 units

This course for second year (Sophomore) Actors not only sharpens their skills as ensemble performers, but also allows for more playfulness, creativity and exploration, cultivating risk-taking and a certain abandon. Divided into two separate sections, the course concentrates one full semester on non-verbal psychological improv to help the student actor achieve a kind of physical truth and spontaneity, while becoming aware of the importance of the body in conveying information; the second semester is devoted entirely to comedy improv and culminates in an original comedy improv show in the UC lobby.

54-245 History of Clothing

Fall: 4,6 units

FOR: All Students, Drama Students have priority This year-long course traces the development of garments of the Western World from Egypt to the beginning of the 20th Century. The shapes of the various elements are considered as well as the way they are worn, how they affect the body and the society from which they spring. A course that involves lectures, slides, research projects, quizzes and exams, the time line continues through the year. Second semester can be taken separately with permission of the instructor. Normally 6 units, a 4 unit option without research projects is available for non-majors.

54-246 History of Clothing

Spring: 4,6 units

FOR: All Students, Drama Students have priority This year-long course traces the development of garments of the Western World from Egypt to the beginning of the 20th Century. The shapes of the various elements are considered as well as the way they are worn, how they affect the body and the society from which they spring. A course that involves lectures, slides, research projects, quizzes and exams, the time line continues through the year. Second semester can be taken separately with permission of the instructor. Normally 6 units, a 4 unit option without research projects is available for non-majors.

54-249 Stagecraft II

Fall: 14 units

Stagecraft II presents advanced shop skills and beginning department head skills for Scenery, Lighting, and Costumes. This course will require additional time during the evening and on weekends.

Prerequisites: 54151 and 54152 OR Instructor Permission

54-250 Intro to Scene Design

Intermittent: 6-21 units

An introduction to the principles and practices of designing scenery emphasizing the interpretation and development of ideas based on a text. Pre-requisites: Basic Design, Studiocraft I

54-252 Introduction to Lighting Design

Spring: 6-21 units

Students explore the physical properties of light in various design applications and develop a process of storytelling that involves analysis, research, exploration, questioning, problem solving and implementation of a successful design product.

Prerequisites: 54251

54-257 Directing: Production II

Fall: 6 units

Assignments as stage manager or assistant director for the Studio and Kresge Theatres.

54-258 Directing: Production II

Spring: 6 units

Assignments as stage manager or assistant director for the Rauh Studio and Chosky Theatres.

54-261 Production Symposium II

Fall: 6 units

Participation in School of Drama productions, usually on shop fabrication or theatre installation crews. Some participants will fill assistant supervisor positions for other students filling creative or production roles. Pre-requisites/Co-requisites: Introduction to Production or instructors permission.

54-262 Production Symposium II

Spring: 6 units

Participation in School of Drama productions, usually on shop fabrication or theatre installation crews. Some participants will fill assistant supervisor positions for other students filling creative or production roles.

Prerequisites: 54163 and 54164

54-264 Welding

Spring: 4 units

An introduction to the four most common metal joining processes, including Oxyfuel processes (welding, brazing, braze welding, and bending), SMAW (stick), GMAW (MIG), and GTAW (TIG). Welding safety, equipment setup and basic welding techniques will be covered.

54-267 Sound Design II

Fall: 9-21 units

Students explore the unique qualities of audio as a design element and the development of a design process through script analysis. Emphasis on the creative application and utilization of the studio in sound shaping and soundscape design.
Prerequisite: 54-166 Introduction To Sound Design for Theater, 54-231 Design For The Stage.

54-268 Sound Design I

Spring: 9 units

Continuation of 54-267; Students explore the unique qualities of audio as a design element. Emphasis on the creative application and utilization of the studio in sound shaping soundscape design. recording techniques, field recording, and mixing.
Prerequisites: 54252

54-269 Studiocraft II

Spring: 6 units

A continuation of 169/170, this course introduces applied drafting practices, perspective drafting, 3D CAD modeling, model building, and other graphical skills.
Prerequisites: 54171 and 54172

54-270 Photoshop/Dreamweaver

Spring: 6 units

Students will begin the semester by learning the basics of Photoshop and progress by mid-semester to being able to explore the visual theatrical design process through Photoshop, in scenery, lighting and costumes, in conjunction with other methods of image creation. During the second half of the semester, students will learn the basics of Dreamweaver and website creation, with each student producing and publishing a professional website.

54-271 Technical Management

Fall: 6 units

Required for all sophomore Design and PTM students. This class establishes a set of standards for creative project management and introduces students to several software packages that can be utilized within these tasks. Prerequisites: 99101 and 54158

54-272 Scenic Fabrication and Installation

Spring: 6-18 units

variable 6-18 units The Scenery Fabrication & Installation course consolidates and builds upon material presented in the first semester of Basic PTM and in the three semesters of Stagecraft class. Whether they intend to pursue careers as technicians, engineers, or managers students much understand how scenery is built and what is involved in the assembly of the scenery in the theatre. Throughout the semester students will explore the materials and equipment used by all kinds of professionals in the fabrication industry. Through this exploration students will become conversant with the kinds of properties, and the advantages and disadvantages of many different items. Along with this exploration is a concurrent investigation of entertainment industry accidents. This material is valuable in how it contextualizes the kind of work students will be involved in, and helps to drive home the very real consequences of errors pertaining to scenery. In the classroom and in lab students in this course will develop their knowledge and processes for building scenery. The course has three basic units. The beginning of the semester focuses on building materials and on tool use. Through the center of the semester course material focuses on traditional scenery practices. The end of the semester material addresses rigging systems and scenery rigging practices. Laboratory assignments tied to this course will consist of carpentry assignments in the shop and carpentry and rigging assignments during load in. Occasionally students pursuing a more customized path may have lab assignments in the paint department in the shop and in the electrics department during install. All students may receive apprentice assignments in the scenery office.

54-273 Technical Direction

Fall: 6-21 units

6-21 units This course is an exploration of techniques and practices of the Technical Director. The class has three main components: classroom presentation of School of Drama production technical direction process, classroom lectures centering on TD process, and project work. Over the course of the semester, students will work on two productions as paper projects. This is an opportunity to have a somewhat less stressful pass through a show, completing estimates, schedules, and drawings designed to help establish a professional foundation for the student as a technical director. All of the course components run concurrently.
Prerequisites: 54271 and 54279

54-277 Stage Management I

Fall: 6-21 units

This class expands on the fall semester through a series of hands-on exercises and production experiences. Students refine skills in cue-calling and managing productions, and will work with other populations on collaborative projects.

54-278 Stage Management I

Spring: 6 units

This class introduces the student to the work of a stage manager on a theatrical production. Students learn the functions and responsibilities of the stage manager. Also covered: blocking notation, cue organization, rehearsal reports and AEA rules and regulations.

54-281 Foundations of Drama III

Fall: 6 units

In this course, we trace the developments of drama through Neo-classicism, German Romanticism, and Weimar Classicism, and trace the development of American theatre from colonial days to the present. We also look at the English Restoration and the rise of non-mainstream para-theatrical entertainments in the Western Hemisphere.

54-282 Foundations of Drama IV

Spring: 6 units

In this course we examine the foundations of 19th and 20th century Realism and also deeply engage the counter-movement of the European avant-garde, the rise of filmmaking, the Federal Theatre Project, and the writings of great American writers from O'Neill to Wilson.

54-289 Growing Theatre Community Outreach

Fall: 9 units

Growing Theater engages students and mentors in the development of a collaborative theater experience. Through Mentor Role Modeling, Growing Theater uses drama as a medium to expose at risk population of fifth graders from a local school to a supportive learning environment that is shared, creative, confident, patient and respectful. Growing Theater Mentors will broaden students' personal and professional outlooks by guiding through them this theatrical process. The resulting play is performed in May at CMU.

54-290 Growing Theatre Community Outreach

Fall and Spring: 9 units

Growing Theater engages students and mentors in the development of a collaborative theater experience. Through Mentor Role Modeling, Growing Theater uses drama as a medium to expose at risk population of fifth graders from a local school to a supportive learning environment that is shared, creative, confident, patient and respectful. Growing Theater Mentors will broaden students' personal and professional outlooks by guiding through them this theatrical process. The resulting play is performed in May at CMU.

54-291 Speech and Phonetics Instruction and Outreach I

Fall: 6 units

This course is designed for mentors to teach children at the 5th grade level to speak in a clear, efficient and pleasing manner with self-confidence. The children will also be able to understand the relationship between sound and speech; realize the differences between American English speech and spelling; relate symbols of IPA to phonemes we use in speech; improve their articulation of Vowels, Consonants and Diphthongs; discover the musical patterns their voices can make; follow directions and drills to learn to discriminate between correct and incorrect productions of Vowels, Consonants and Diphthongs; develop the techniques for memorization of challenging poetry.

54-292 Speech and Phonetics Instruction and Outreach II

Spring: 6 units

This course is designed for mentors to teach children at the 5th grade level to speak in a clear, efficient and pleasing manner with self-confidence. The children will also be able to understand the relationship between sound and speech; realize the differences between American English speech and spelling; relate symbols of IPA to phonemes we use in speech; improve their articulation of Vowels, Consonants and Diphthongs; discover the musical patterns their voices can make; follow directions and drills to learn to discriminate between correct and incorrect productions of Vowels, Consonants and Diphthongs; develop the techniques for memorization of challenging poetry and participate in a presentation for family and friends using the skills they have learned.

54-294 Make-Up

Spring: 2 units

MAKE UP FOR ACTORS PRE-REQUISITES: School of Drama Student FOR: School of Drama Students with priority given to Actors and Costume Design majors DESCRIPTION: Basic techniques of stage make-up and their adaptation to theatrical styles. MAKE UP FOR DESIGNERS PRE-REQUISITES: Declared major in Costume Design FOR: Graduate and Undergraduate Costume Design majors DESCRIPTION: This course teaches designers the basic approach and processes used in designing makeup for theatrical production. It covers techniques of stage make-up application and the adaptation of theatrical styles as related to design.

54-301 Acting III

Fall: 10 units

This is a two-semester course in Acting for Third-Year Actors & MTs who will explore performance within directed structure in various non-Fourth-Wall forms of Theatre including: Greek Tragedy, the Greek Chorus, Moliere Comedy & Brecht. This is not a course that will aspire to provide any "correct" way to play various "styles". Rather, it is a course in which to acquire new tools & perspectives when working in new theatrical worlds. Goals include: to find the appropriate level of external expression to meet the demands of the particular text & its directed world, & to "fill the Form" believably & passionately; to make active choices within a directed framework; to learn to work within industry standards; to learn the nature of the actor's "homework" in a directed framework; to include the Audience in the work.

Prerequisites: 54201 and 54202

54-302 Acting III

Spring: 10 units

This is a two-semester course in Acting for Third-Year Actors & MTs who will explore performance within directed structure in various non-Fourth-Wall forms of Theatre including: Greek Tragedy, the Greek Chorus, Moliere Comedy & Brecht. This is not a course that will aspire to provide any "correct" way to play various "styles". Rather, it is a course in which to acquire new tools & perspectives when working in new theatrical worlds. Goals include: to find the appropriate level of external expression to meet the demands of the particular text & its directed world, & to "fill the Form" believably & passionately; to make active choices within a directed framework; to learn to work within industry standards; to learn the nature of the actor's "homework" in a directed framework; to include the Audience in the work.

Prerequisites: 54301

54-303 Speech III

Fall: 3 units

(Voice) The actors continue to strengthen their vocal techniques with voice classes, which become specific in their purpose and require the students to become responsible for their own preparation process. The class also focuses on particular performance challenges in private tutorial work. (Dialects & Accents) Dialects and accents class meets twice weekly in order to build a repertoire of ten American, British, Irish dialects and/or European accents. Each actor also develops an independent project in order to discover a process of research for additional dialects he/she may encounter in the professional world.

54-304 Speech III

Spring: Mini Session - 3 units

(Voice) The actors continue to strengthen their vocal techniques with voice classes, which become specific in their purpose and require the students to become responsible for their own preparation process. The class also focuses on particular performance challenges in private tutorial work. (Dialects & Accents) Dialects and accents class meets twice weekly in order to build a repertoire of ten American, British, Irish dialects and/or European accents. Each actor also develops an independent project in order to discover a process of research for additional dialects he/she may encounter in the professional world.

54-305 Voice/Alexander III

Fall: 5 units

Review of Linklater work, continuation of Alexander work and introduction to the Fitzmaurice voice work. Students develop personal warm ups for particular performance challenges. Students are assigned text work complementary to acting class work, as well as personal writing projects in conjunction with the Head of Playwriting. Students are also undertake the role of voice captains in productions.

54-306 Voice/Alexander III

Spring: 5 units

Students continue in Linklater voice and Fitzmaurice voice, incorporating the principles of the Alexander Technique. Students are assigned special voice research projects to do with an area of interest in voice science, voice psychology or other area. Students integrate voice with acting class and performance work and continue as voice captains.

54-307 Movement III

Fall: 4 units

Prerequisite: 54-107, 54-108, 54-207, 54-208, or permission of the instructor. This course introduces students to the basic exercises of physical actor training developed by Tadashi Suzuki and examines more advanced uses of the Viewpoints method of actor training. Physically rigorous, this course challenges not only physical stamina, but also concentration, focus and the actor's sense of discipline. The use of spoken text is incorporated into the exercises in an integration of all the physical aspects of the actor's craft. This course is also designed to complement and inform the actor's entry into rehearsal and performance work. This course is required for all third year Acting majors.

54-308 Movement III

Spring: 5 units

Prerequisite: 54-307, or permission of the instructor This course focuses on the art of stage combat. Basic techniques of unarmed stage violence are studied and an introduction to other weapons such as knife and/or single rapier may be included. Emphasis is place not only on technique, but the acting of scenes of violence found in both classical and contemporary plays. This is a required course for all third year Acting majors.

54-309 Theatre Lab

Fall: 9 units

This is a two-semester class which teaches the collaborative process of theatre -- including the role of the living dramatic writer. New scripts are written by graduate dramatic writers, then developed and realized by senior actors, senior dramaturgs graduate and undergraduate directors with the playwright. This work results in 10-minute play scripts, one acts, monologue dramas, and the texts for the MFA Thesis Productions. This class is co-taught by the Acting Dramatic Writing, Dramaturgy and Directing Options.

54-310 Theatre Lab

Spring: 9 units

This is a two-semester class which teaches the collaborative process of theatre -- including the role of the living dramatic writer. New scripts are written by graduate dramatic writers, then developed and realized by senior actors, senior dramaturgs graduate and undergraduate directors with the playwright. This class is co-taught by the Acting Dramatic Writing, Dramaturgy and Directing Options.

54-311 Acting Symposium III

Fall: 16 units

Performance training through projects at different levels of difficulty and staging, directed by students and presented in the studio theatre. The actor has the opportunity to put into practice with his/her peers, in a creative and experimental atmosphere, the principles and techniques developed in the classroom.

54-312 Acting Symposium III

Spring: 16 units

Performance training through projects at different levels of difficulty and staging, directed by students and presented in the studio theatre. The actor has the opportunity to put into practice with his/her peers, in a creative and experimental atmosphere, the principles and techniques developed in the classroom.

54-313 Ballet III

Fall: 3 units

This course is dedicated to honing technical skills, expanding the classical dance vocabulary to the next level of difficulty, and addressing issues of strength, stamina, and endurance. Course closed: Only for Music Theatre majors in Drama. Prerequisite: Permission of instructor

54-314 Ballet III

Spring: 3 units

This course continues to hone technical skills, expand the classical dance vocabulary to the next level of difficulty, and address issues of strength, stamina, and endurance. Course closed: Only for Music Theatre majors in Drama. Prerequisite: 54-313 and Permission of instructor

54-315 Jazz III

Fall: 2 units

This course is to expand the versatility of the student dancer to master more complex exercises, in dynamics, direction and rhythm using Jazz styles examined by decades. Understanding the 20th century historical background of the 20's, 30's 40's, 50's 60's and 70's. Course closed: Only for Music Theatre majors in Drama. Prerequisite: Permission of instructor

54-316 Jazz III

Spring: 2 units

This course continues to expand the versatility of the student dancer to master more complex exercises, in dynamics, direction and rhythm using Jazz styles examined by decades. Understanding the 20th century historical background of the 20's, 30's 40's, 50's 60's and 70's. Course closed: Only for Music Theatre majors in Drama. Prerequisite: 54-315 and Permission of instructor

54-317 Singing for Actors III

Fall: 3 units

The students have a class voice experience which includes a physical and vocal warm-up and discussion and practice of healthy singing technique. There is group and individual rehearsal of potential audition and performance material. Toward the end of the term, there are weekly opportunities to perform in public, thus preparing for auditions.

54-318 Singing for Actors III

Spring: 3 units

The students have a class voice experience which includes a physical and vocal warm-up and discussion and practice of healthy singing technique. There is group and individual rehearsal of potential audition and performance material. Toward the end of the term, there are weekly opportunities to perform in public, thus preparing for auditions. Prerequisites: 54207 and 54208

54-319 Cabaret

Fall: 6 units

The Art of Cabaret: Explores the use of Stories and Song to communicate life experiences within an intimate setting, breaking down the invisible fourth wall for honest communication. The course includes a section on the use of the microphone for singers. This Study produces two Cabarets containing Material on a chosen Theme to provide hands-on Song Expression in a public forum. Prerequisites: 54220

54-320 Music Theatre Scenes

Spring: 4 units

Study of the marriage of spoken and sung text- i.e the marriage of drama and music. Class study includes Scenes extracted from the Musical Theatre canon, including Scenes from a variety of styles and eras. The class explores how the Singing Actor seques from speech to music, thus strengthening the scene through the emotional flight music brings to the script.

54-321 Directing III: Forms and Formats

Fall: 9 units

An examination of various directing styles with particular attention to: verse forms including Greek and Elizabethan, comedy/ farce texts and Early 20th century styles including Ibsen and Shaw. On occasion, guest directors for our main-stage productions will be engaged to teach the style of the production that they are presently working on. Alternately, there is the possibility of this semester being used for an applied internship with a major producing organization.

54-322 Directing III: Forms and Formats

Spring: 4,9 units

This two-semester class for 3rd-Year Directors is directly related to the work in Directing 3/Acting Lab 2. The Seminar consists of organizational meetings, lectures & discussions relevant to the current class work -- such as ground planning, rehearsal organization, vision, genre differentiation, new formats, working with actors, etc.

54-323 Tap III

Fall: 2 units

This course expands tap vocabulary and clear precision of execution through moderately difficult and extended combinations. Course closed: Only for Music Theatre majors in Drama. Prerequisites: 54223 and 54224

54-324 Tap III

Spring: 2 units

This course continues to expand tap vocabulary and clear precision of execution through moderately difficult and extended combinations. Course closed: Only for Music Theatre majors in Drama. Prerequisite: 54-323 and Permission of instructor Prerequisites: 54323

54-325 Actor Dance III

Fall: 3 units

This course uses basic and fundamental contemporary Jazz styles, i.e. Latin, Blues, Lyric, African, to technically train the body using isolations and rhythmic patterns. Course closed: Only for Acting majors in Drama. Prerequisite: Permission of instructor

54-326 Actor Dance III

Spring: 3 units

This course continues to use basic and fundamental contemporary Jazz styles, i.e. Latin, Blues, Lyric, African, to technically train the body using isolations and rhythmic patterns. Course closed: Only for Acting majors in Drama. Prerequisite: 54-325 and Permission of instructor

54-330 Introduction to Stage Management

Spring: 6-18 units

This course is intended to provide students an opening to the knowledge and skills of the professional stage manager. It will also illuminate the qualities of a good stage manager specific to personality and human interaction. Within this course we will examine the role of the stage manager throughout the full scope of creating a production, including preparatory work, rehearsal period, technical rehearsal, performance and closing.

54-331 Scene Design I

Fall: 9-21 units

Students will spend the year in an exciting and intensive exploration of the process of Scene Design as well as an examination of the nature of creativity and storytelling. Students will also engage extensively in the skills a professional Scene Designer requires, such as drafting, drawing, model making, painting and general collaborative skills. Students will be expected to deal with in-depth research, scriptural examinations, careful arrangements of space, composition and groundplan, conceptual structure, real life obstacles and the elements of a successful final project. By the end of this course, students will have improved their overall design skills, have some projects they can include in their portfolio and have created new routes toward their creativity. (pre-req, intro to Scene Design)

54-332 Scene Design I

Spring: 6,9 units

A continuation of the fall semester of Scene Design One. There will be added emphasis on collaboration during the spring semester. Concentration on the design process, the director-designer relationship, and the refinement of conceptual development will be highlighted.

54-333 Production Personnel Management

Fall: 6-21 units

Fall: 6-21 units Study of the management of production personnel for live theatrical productions. In depth analysis of union contracts from a management perspective: AEA, IATSE, USA. Projects in scheduling and budgeting based on those contracts. Study of hiring, evaluating, and retaining a quality staff. Examination of the role of safety protocols in production. The Course concentrates on the relationship between the Production Manager and all of the personnel that one comes in contact with.

54-334 Production Resource Management

Spring: 6-18 units

Spring: 6-18 units This course examines the management of resources for the production of live theatrical productions. We start with analysis of scripts, to find the foundation for resource allocation. Then we move on to study the allocating two of the largest production resources: time and money. A significant exploration of the tracking of time and money extends throughout the course, with half of the class sessions taking place in a computer cluster, where we concentrate on advanced application of Excel, Access, and specialized calendar software.

54-337 Scene Painting II

Fall: 4 units

This is a year long course designed to explore more complex scene painting problems with an emphasis on professional standards. Projects in the first semester will address such topics as: translucency, trop l'oiel, aging techniques, signage, perspective,

and working 3 dimensionally. Adequate mastery of skills in the first semester will permit more freedom in the second semester to do independent projects or group projects for public display.
Prerequisites: 54237 and 54238

54-338 Advanced Scene Painting
Spring: 6 units

This is a year long course designed to explore more complex scene painting problems with an emphasis on professional standards. Projects in the first semester will address such topics as: translucency, tromp l'oeil, aging techniques, signage, perspective, and working 3 dimensionally. Adequate mastery of skills in the first semester will permit more freedom in the second semester to do independent projects or group projects for public display.
Prerequisites: 54237 and 54238 and 54337

54-339 Stage Management Seminar
Fall: 3 units

This class provides stage managers an opportunity to participate in in-depth discussion about the production process. Specific issues related to CMU productions and troubleshooting problems are a particular focus. The class also presents guest speakers on related topics and will work on longer-term projects as needed.

54-340 Stage Management Seminar
Spring: 3 units

This class provides stage managers an opportunity to participate in in-depth discussion about the production process. Specific issues related to CMU productions and troubleshooting problems are a particular focus. The class also presents guest speakers on related topics and will work on longer-term projects as needed.

54-341 Costume Design I
Fall: 9 units

A two semester course that engages students with Paul Tazewell, Susan Tsu and guest designers. Tsu teaches first semester. Principals and elements of design including color theory are examined in discreet costume projects. Strong process orientation. Television Workshop with CMU alumni annually. Final project covers play analysis, research, emotional response, deconstruction of script, character analysis, awareness of all design disciplines, drawing, painting, swatching, and spec sheets. Students may participate in Design Workshops such as the annual Dance/Light/Costume production design. PRE-REQUISITES: Drawing For The Theatrical Designer, Figure Drawing, FOR: First year graduate costume majors and upper level undergraduates with declared majors. Non-major Design, PTM and Drama students and all others by Instructor Approval only.
Prerequisites: 54245 and 54347

54-342 Costume Design I
Spring: 9 units

The second semester of a two semester course that engages students with Paul Tazewell, Susan Tsu and guest designers. Tazewell teaches second semester which further emphasizes the use of design principles and techniques to communicate and express character, mood, and style in support of the written text. Figure drawing and painting techniques are incorporated with studies on a basic approach to the figure and how it is costumed to suit the production. Emphasis is placed on interpretation, director-designer communication and the design process. Students may participate in Design Workshops such as the annual television project produced at Pittsburgh's Public Television station WQED and the collaborative Dance/Light/Costume production design. PRE-REQUISITES: Drawing For The Theatrical Designer, Figure Drawing FOR: First year graduate costume majors and upper level undergraduates with declared majors. Non-major Design, PTM and Drama students and all others by Instructor Approval only.
Prerequisites: 54246 and 54348

54-343 Costume Construction I
Fall: 4,6 units

FOR: Sophomores This hands on practical application course is a study of primary construction principals with emphasis on the development of patterns from the basic costume shapes through history. Primary shapes first semester include men's and women's multi-piece bodices, historic sleeve shapes, breeches and skirts. The ability to look at a picture and interpret it to create the shape in fabric is stressed. Second semester, draping, boots and millinery are explored with some garments patterned for departmental productions. Techniques for communicating with the designer and fitting the actor are developed. PRE-REQUISITES:None

54-344 Costume Construction I
Spring: 6 units

FOR: Sophomores This hands on practical application course is a study of primary construction principals with emphasis on the development of patterns from the basic costume shapes through history. Primary shapes first semester include men's and women's multi-piece bodices, historic sleeve shapes, breeches and skirts. The ability to look at a picture and interpret it to create the shape in fabric is stressed. Second semester, draping, boots and millinery are explored with some garments patterned for departmental productions. Techniques for communicating with the designer and fitting the actor are developed. PRE-REQUISITES:None

54-346 Introduction to Costume Construction
Spring: 4 units

For: Declared Costume Design Sophomores Students will build on the skills developed in stagecraft and on Costume crews from their first year. Emphasis will be placed on refining construction skills and learning finishing techniques. Students will also be provided with the skills necessary to perform successfully and safely as an assistant to a crew head.

54-347 Figure Drawing I
Fall: 4 units

This one semester course is a PRE-REQUISITE for Figure Drawing II. Enrollment priority is given to Costume Design majors. DESCRIPTION: This course will explore the realistic and expressive depiction of the human form. Students will work from live models each week, addressing such topics as anatomy and structure, gesture and movement, proportion and composition and individual expression. A variety of 2-dimensional media will be explored, as well. This course is designed to give students a solid grounding in their understanding of the human form and to increase their facility and confidence in drawing it accurately and expressively.

54-348 Figure Drawing
Spring: 6 units

PRE-REQUISITES: If taking Figure Drawing II, both semesters of Figure Drawing I FOR: Costume Majors have priority, then Design Majors. First experience should be in Zamborsky section. DESCRIPTION: This year-long course explores the realistic and expressive depiction of the human form primarily in two dimensional media. Working primarily from the live model, exercises will be undertaken that address gesture, proportion, movement, anatomy and structure, composition and expressive form. Students will experience a variety of media and formal approaches to the figure, working from nude, draped, and clothed male and female models. A primary goal of the class is to develop the ability to create the human figure from imagination, based on intensive empirical study of the forms and structures of the human body from life. Although most of the work takes place in class, some outside study is required.

54-349 Automated Lighting Technology
Spring: 6 units

Students are exposed to a range of automated lighting equipment and develop skills in the implementation of them in a production situation. Programming of automated fixtures on a variety of consoles is emphasized. Pre-requisites: Prerequisites: 54-351
Prerequisites: 54351 and 54352

54-350 Pre-visualization Lighting Software
Spring: 6 units

Students become familiar with pre-visualization software programs as a tool for problem solving design issues and communicating design intent. Programs may include WYSIWYG, Visionary, ESP Vision and Martin Show Designer. Prerequisites: 54-351
Corequisites: 54-349
Prerequisites: 54349

54-351 Lighting Design I
Fall: 9-21 units

The student's ability to analyze and translate information in the script to descriptive stage pictures is developed in a more in-depth process. Verbal, written and visual communication of ideas is emphasized and explored through texts and lab work. Issues of collaboration with the director and other members of the design team are discussed as part of the design process. Prerequisites: 54252
Prerequisites: 54252

54-352 Lighting Design I
Spring: 9 units

The student's ability to analyze and translate information in the script to descriptive stage pictures is developed in a more in-

depth process. Verbal, written and visual communication of ideas is emphasized and explored through texts and lab work. Issues of collaboration with the director and other members of the design team are discussed as part of the design process. This is a continuation of the fall semester. Prerequisites: 54351
Prerequisites: 54351

54-353 Structural Design I

Fall: 9 units

Required for all senior undergraduate Technical Direction students. A concentrated training in Structural Design specifically developed for the theater technician. This course teaches the process of Allowable Stress Design for the engineering of scenic structures in wood and steel.

54-354 Structural Design II

Spring: 9 units

Required for all senior undergraduate Technical Direction students. Upon completion of this two-semester sequence, students are familiar with beam and column design/specification, truss design, tensile systems and structural connections.
Prerequisites: 54353

54-357 Directing: Production III

Fall: 12 units

Assignments as stage manager or assistant director for the Studio and Kresky Theatres.

54-358 Directing: Production III

Spring: 12 units

Assignments as stage manager or assistant director for the Rauh Studio and Chosky Theatres.

54-359 Stage Management 2

Fall: 6 units

This class provides an in-depth exploration of Actors Equity Association and work rules for actors and stage managers. Through careful reading of contracts and guidelines, we will gain an understanding of current practice and the stage manager's place within it. The class will also study related unions and current issues affecting the theatre.

54-365 Machine Design I

Fall: 9 units

Required for all senior undergraduate Technical Direction students. In this course, concepts from Physics of Stage Machinery are applied to the specification, selection, design and assembly of real-world mechanical components for the realization of winches, turntables, wagons and lifts for theatrical use.
Prerequisites: 54366 and 54378

54-366 Physics of Stage Machinery

Spring: 9 units

Required for all junior undergraduate PTM students. This is a one-semester pure Physics class designed to give theater technicians a base knowledge of Newtonian Physics, a pre-requisite for later courses in Machine Design. For this course, I have obtained special permission to use an unpublished text by Alan Hendrickson of the Yale University school of Drama.

54-367 Lighting Design Skills

Fall: 6 units

Students will concentrate on developing the skills necessary for lighting designers to successfully implement their designs in the theatre. Content includes communication, CAD programs, paperwork, focusing the show, programming conventional and moving light consoles, cue writing and expectations and responsibilities of the design assistant.
Prerequisites: 54251 and 54252

54-368 Production Electrics

Spring: 4-18 units

Class content includes practical skills in lighting and electrical theory and practice as it pertains to entertainment lighting as well as development of managerial techniques used by Production Electricians in the industry. Students completing the class satisfactorily will be prepared for Master Electrician assignments on School of Drama productions as well as similar positions outside of the School. Prerequisites: 54-252
Prerequisites: 54251

54-378 Technical Design I

Spring: 9 units

This course is an exploration of techniques and practices of Technical Designers. The class has four main components: an exploration

of the types of strategies used by Technical Designers to arrive at solutions, building an expert vocabulary for discussion of technical design issues, development of actual technical solutions, on paper, in discussion, and in the shop, discussion of any pertinent technical issues for any of the school productions while in development.
Pre-requisites/Co-requisites: Technical Direction or instructor's permission

Prerequisites: 54273

54-379 2-d Scene Design Skills

Fall: 6 units

Students explore a variety of two dimensional media and techniques as they pertain to building ideas for the Scene Designer. Students will investigate drawing, watercolor, gouache, acrylics, drafting, rendering, basic thumbnails, paint elevations and markers.

54-380 Music Reading for Drama Technicians

Spring: 3 units

This class gives the basics of music theory, musical terminology and score reading. Students focus on the difference in various musical scores, ie. piano/vocal, full, hand written scores. Students are guided in classroom listening which a wide variety of music including, opera, musical theatre, ballet, and choral/orchestra works.

54-381 History of Drama

Fall: Mini Session - 3 units

These mini-courses are "special topics," created uniquely at the discretion of the Dramatic Literature and Dramaturgy faculty, addressing issues in dramatic literature, critical theory of drama, or theatre history that the professor finds topical or significant. Individual course descriptions will be available from the professor.

54-382 History of Drama II

Spring: Mini Session - 3 units

These mini-courses are "special topics," created uniquely at the discretion of the Dramatic Literature and Dramaturgy faculty, addressing issues in dramatic literature, critical theory of drama, or theatre history that the professor finds topical or significant. Individual course descriptions will be available from the professor.

54-386 Scene Design Skills 3D

Spring: 4 units

Students explore a variety of three dimensional media and techniques as they pertain to building ideas for the Scene Designer. Students will investigate many aspects of model building, from basic structural ideas to complex organic and architectural forms, furniture, and advanced techniques such as metal work. Students will also work in depth with the concepts of working in three dimensional space through ideas of scale and layering.

54-387 Dramaturgy : Production III

Fall: 10 units

Working as a production dramaturg for a senior thesis or grad show, or as an assistant dramaturg for a season show, in junior year.

54-388 Dramaturgy: Production III

Spring: 10 units

Working as a production dramaturg for a senior thesis or grad show, or as an assistant dramaturg for a season show, in junior year.

54-389 Growing Theatre Community Outreach

Fall: 9 units

Growing Theater engages students and mentors in the development of a collaborative theater experience. Through Mentor Role Modeling, Growing Theater uses drama as a medium to expose at risk population of fifth graders from a local school to a supportive learning environment that is shared, creative, confident, patient and respectful. Growing Theater Mentors will broaden students' personal and professional outlooks by guiding through them this theatrical process. The resulting play is performed in May at CMU. s.

54-390 Growing Theatre Community Outreach

Spring: 9 units

Growing Theater engages students and mentors in the development of a collaborative theater experience. Through Mentor Role Modeling, Growing Theater uses drama as a medium to expose at risk population of fifth graders from a local school to a supportive learning environment that is shared, creative, confident, patient and respectful. Growing Theater Mentors will broaden students' personal and professional outlooks by guiding through them this theatrical process. The resulting play is performed in May at CMU. s.

54-393 My True Voice

Fall: 6 units

This course is designed for mentors to teach children at the 5th grade level to speak in a clear, efficient and pleasing manner with self-confidence. The children will also be able to understand the relationship between sound and speech; realize the differences between American English speech and spelling; relate symbols of IPA to phonemes we use in speech; improve their articulation of Vowels, Consonants and Diphthongs; discover the musical patterns their voices can make; follow directions and drills to learn to discriminate between correct and incorrect productions of Vowels, Consonants and Diphthongs; develop the techniques for memorization of challenging poetry.

54-394 My True Voice

Spring: 6 units

This course is designed for mentors to teach children at the 5th grade level to speak in a clear, efficient and pleasing manner with self-confidence. The children will also be able to understand the relationship between sound and speech; realize the differences between American English speech and spelling; relate symbols of IPA to phonemes we use in speech; improve their articulation of Vowels, Consonants and Diphthongs; discover the musical patterns their voices can make; follow directions and drills to learn to discriminate between correct and incorrect productions of Vowels, Consonants and Diphthongs; develop the techniques for memorization of challenging poetry and participate in a presentation for family and friends using the skills they have learned.

54-401 Camera Lab

Fall: 3,6 units

This is a year long course required for senior undergraduate directing and acting majors and second year graduate directors. The students are introduced to some fundamental ideas about story telling with a camera. The students learn and practice both single and multi-camera techniques. There are a series of projects for the students to encounter and practice acting, directing, and designing for the camera.

54-402 Camera Lab

Spring: 3 units

Advanced scene study: selectivity, clarity; the honing of performance techniques. Professional requirements, the practical extension of the training. Audition and T.V. techniques. Preparation for a New York presentation at the end of the Spring semester.

54-403 Voice and Speech IV

Fall: 6 units

(Voice) The senior actors continue to strengthen their voice work with individualized voice classes and tutorials. The voice work often addresses particular issues, which these actors encounter in the mainstage productions. Students also re-visit classical text work and build on their sophomore year preparation with additional Shakespeare material. The pieces are prepared as professional audition selections in this work. (Voice-Over Acting) A commercial aspect of the voice work is introduced, developed and marketed in the Voice-Over Acting class. The course presents information which is then applied to narrating radio and television commercials, industrials, feature-length animations, books on tape, CD-ROM videos, computer software programs, etc. Texts are developed for two demo tapes, which are prepared in class and readied for a professional studio-taping session.

54-404 Voiceover

Spring: Mini Session - 6 units

(Voice) The senior actors continue to strengthen their voice work with individualized voice classes and tutorials. The voice work often addresses particular issues, which these actors encounter in the mainstage productions. Students also re-visit classical text work and build on their sophomore year preparation with additional Shakespeare material. The pieces are prepared as professional audition selections in this work. (Voice-Over Acting) A commercial aspect of the voice work is introduced, developed and marketed in the Voice-Over Acting class. The course presents information which is then applied to narrating radio and television commercials, industrials, feature-length animations, books on tape, CD-ROM videos, computer software programs, etc. Texts are developed for two demo tapes, which are prepared in class and readied for a professional studio-taping session.

54-405 Graduate Directing

Fall: 6 units

Graduate Directing is a semester long course for first and second year graduate directors and senior actors entitled "Classics in another time and place". It explores the techniques as well as the

variety of challenges the director and the actor deal with when they do transplant the original setting of a well known classical play into a radically different time frame or place of action.

54-406 Graduate Directing

Spring: 6 units

Graduate Directing is a semester long course for first and second year graduate directors and senior actors entitled "Classics in another time and place". It explores the techniques as well as the variety of challenges the director and the actor deal with when they do transplant the original setting of a well known classical play into a radically different time frame or place of action.

54-407 Movement IV

Fall: 4 units

Movement IV is a cross-option course, wherein sophomore Designers build masks for the Senior Actors to use in the creation of a movement/mask piece based on a classic text. (Examples: HEDDA GABLER, CAT ON A HOT TIN ROOF, DRACULA, CYRANO). The course gives Senior Actors an opportunity to create an original ensemble performance piece, bringing over 30 masks to life, using skills learned in the previous classes in mask work (Neutral Mask, Commedia dell'Arte, character and larval masks). Due to the necessity of working as an ensemble in the creation of this piece, the students must work together in various roles: as actors, of course, but also as directors, writers, dramaturgs and stage managers; this course offers a rare chance for students to experiment with actor-created theatre, as well as, because it is cross-option, an opportunity for actors and designers to work together to create masks which are able to be brought to life through movement, that are comfortable, offer enough visibility, are secure during activity, etc. - a unique learning laboratory for designers and actors to interact involving both artistic and practical issues related to the creation and use of these masks as theatrical metaphor.

Prerequisites: 54307 and 54308

54-408 Movement IV

Spring: 4 units

In the Senior year, students may study stage combat, including hand-to-hand, quarterstaff, and single rapier, leading to scene work incorporating these skills. Other studies might include dramatic acrobatics, circus skills, and Eastern disciplines such as yoga, Tai Chi, etc. Focus on personal physical style; application of movement training on the mainstage in performance.

54-409 Theatre Lab

Fall: 4,9 units

This is a two-semester class which teaches the collaborative process of theatre -- including the role of the living dramatic writer. New scripts are written by graduate dramatic writers, then developed and realized by senior actors, senior dramaturgs graduate and undergraduate directors with the playwright. This work results in 10-minute play scripts, one acts, monologue dramas, and the texts for the MFA Thesis Productions. This class is co-taught by the Acting Dramatic Writing, Dramaturgy and Directing Options.

54-410 Theatre Lab

Spring: 9 units

This is a two-semester class which teaches the collaborative process of theatre -- including the role of the living dramatic writer. New scripts are written by graduate dramatic writers, then developed and realized by senior actors, senior dramaturgs graduate and undergraduate directors with the playwright. This class is co-taught by the Acting Dramatic Writing, Dramaturgy and Directing Options.

54-411 Acting Symposium IV

Fall: 20 units

Participation outside of class requirements in departmental productions. Putting into practice the techniques acquired over the years of training and exploring the development of a performance played before the public over two weeks.

54-412 Acting Symposium IV

Spring: 20 units

Participation outside of class requirements in departmental productions. Putting into practice the techniques acquired over the years of training and exploring the development of a performance played before the public over two weeks.

54-413 Showcase

Fall: Mini Session - 4 units

Senior acting class for actors and Mt's who are in good standing and in position to graduate in the Spring. Preparation for the New York and Los Angeles Showcase presentations.

54-414 Showcase

Spring: 9 units

Senior acting class for actors and Mt's who are in good standing and in position to graduate in the Spring. Preparation for the New York and Los Angeles Showcase presentations.

54-415 Broadway Styles

Fall: 4 units

This course is designed to provide the student with a practical and historical knowledge of the dance repertoire in American Musical Theater using the original choreography from prominent Broadway choreographers. Course closed: Only for Music Theatre majors in Drama. Prerequisite: Permission of instructor

54-416 Broadway Styles

Spring: 4 units

This course continues to provide the student with a practical and historical knowledge of the dance repertoire in American Musical Theater using the original choreography from prominent Broadway choreographers. Course closed: Only for Music Theatre majors in Drama. Prerequisite: 54-415 and Permission of instructor

54-422 Directing IV

Spring: 6 units

Encounter major 20th century theatrical and dramatic movements. Specific concentration on directorial innovations in the last half of the 20th century

54-423 Tap IV

Fall: 2 units

This course presents advance tap vocabulary and challenges the ability of the student to master advanced repertoire at a consistent professional level. Course closed: Only for Music Theatre majors in Drama. Prerequisite: Permission of instructor
Prerequisites: 54323 and 54324

54-424 Tap IV

Spring: 2 units

The course continues to presents advance tap vocabulary and challenges the ability of the student to master advanced repertoire at a consistent professional level. Course closed: Only for Music Theatre majors in Drama. Prerequisite: 54-423 and Permission of instructor
Prerequisites: 54423

54-431 Scenography

Fall: 9 units

The first semester of a full-year investigation of the processes, challenges and techniques that support the design development of scenic environments for live-performance and camera-based industries. Assignments of both produced and theoretical projects are evaluated through text analysis and pragmatic problem-solving. Disciplines of conceptualization, collaboration and communication are explored and engaged. Prerequisites: 54-331 & 54-332
Prerequisites: 54331

54-432 Scene Design II

Spring: 9 units

The second semester of a full-year investigation of the processes, challenges and techniques that support the design development of scenic environments for live-performance and camera-based industries. Assignments of both produced and theoretical projects are evaluated through text analysis and pragmatic problem-solving. Disciplines of conceptualization, collaboration and communication are explored and engaged. Prerequisite: 54-431

54-433 Producing for TV and Film

Fall and Spring: 9 units

The course will provide an overview and introduction to the creative and administrative processes involved in creating a production. It will focus on the role of the producer as creator, inspirer of creativity, and administrator. The responsibilities of a producer in a variety of production situations: film, television, and independent will be discussed and compared. We will discuss current issues, people and companies that are relevant to the industry, as well as job opportunities. Students will be required to present an oral personal pitch, project pitch, and produce a short (3-5 minute) piece as their final.

54-437 Acting IV

Fall: 4 units

An integration of training and craft approaches related to the rehearsal process featuring a comprehensive approach to text. Students will also examine their propensities and limitations in order to expand their emotional physical vocal and intellectual range.

54-438 Acting for the Camera

Spring: 3 units

An integration of training and craft approaches related to the rehearsal process featuring a comprehensive approach to text. Students will also examine their propensities and limitations in order to expand their emotional physical vocal and intellectual range.

54-439 Stage Management Seminar

Fall: 3 units

This class provides stage managers an opportunity to participate in in-depth discussion about the production process. Specific issues related to CMU productions and troubleshooting problems are a particular focus. The class also presents guest speakers on related topics and will work on longer-term projects as needed.

54-440 Stage Management Seminar

Spring: 3 units

This class provides stage managers an opportunity to participate in in-depth discussion about the production process. Specific issues related to CMU productions and troubleshooting problems are a particular focus. The class also presents guest speakers on related topics and will work on longer-term projects as needed.

54-441 Costume Design II

Fall: 9 units

A two-semester course. First semester focuses on an exploration of pragmatic solutions in design development. Disciplines of collaboration, conceptualization and communication as the fundamentals of successful professional development are explored, discussed and evaluated within the context of class projects and departmental production assignments. Projects will emphasize problem-solving goals in text analysis, research, the selection of period detail and project organization, as well as graphic skills development and refinement. This upper level course exposes students to a range of genres that includes theatre, film, opera, the annual television projects including the Television Workshop with CMU alumni and the short made for television plays produced at Pittsburgh's Public Television station WQED, as well as the collaborative Dance/Light/Costume production design. PRE-REQUISITES: Costume Design I, Drawing For The Theatrical Designer, Figure Drawing, History of Clothing. FOR: upper level undergraduates with declared majors.
Prerequisites: 54245 and 54341 and 54347

54-442 Costume Design II

Spring: 9 units

The second semester of a two-semester course. The beginning of the semester culminates the annual collaborative Dance/Light/Costume production design. Fabric identification is studied early in the semester. Created to augment the experience of students who are already designing School of Drama productions, this course is tailored every year to develop student's existing design sensibilities and skills, build their portfolios and deepen the exploration of their individual voices as artists. Students receive career counseling and mentorship on the preparation of their portfolios, resumes and cover letters for professional interviews. PRE-REQUISITES: Costume Design I, first semester of Costume Design II, Drawing For The Theatrical Designer, Figure Drawing, History of Clothing. FOR: upper level undergraduates with declared majors.
Prerequisites: 54246 and 54448

54-443 Costume Construction II

Fall: 6 units

FOR: All Costume Majors have priority Advanced problems in costume building and pattern development are individually assigned to strengthen the skills of the student. Projects may be drawn from actual designs for productions if the challenge is suitable for the student's development. This course may be taken for 1 or 2 semesters, starting either Fall or Spring PRE-REQUISITES: Both semesters of Costume Construction I
Prerequisites: 54343 and 54344

54-444 Costume Construction II

Spring: 6 units

FOR: All Costume Majors have priority Advanced problems in costume building and pattern development are individually assigned to strengthen the skills of the student. Projects may be drawn from actual designs for productions if the challenge is suitable for the student's development. This course may be taken for 1 or 2 semesters, starting either Fall or Spring PRE-REQUISITES: Both semesters of Costume Construction I
Prerequisites: 54343 and 54344

54-445 Business Practices for Designers

Fall: Mini Session - 3 units

A brief introduction for design-oriented pre-professionals to the issues, challenges and conventionally-held practices of responsible self-employment. Specific issues and problem-solving skills will be introduced through lectures, discussions and handouts. No testing or project work outside of class is anticipated for the successful completion of this course. Prerequisite: open to Seniors only

54-447 Figure Drawing II

Fall: 4 units

PRE-REQUISITES: If taking Figure Drawing II, both semesters of Figure Drawing I FOR: Costume Majors have priority, then Design Majors. First experience should be in Zamborsky section. DESCRIPTION: This year-long course explores the realistic and expressive depiction of the human form primarily in two dimensional media. Working primarily from the live model, exercises will be undertaken that address gesture, proportion, movement, anatomy and structure, composition and expressive form. Students will experience a variety of media and formal approaches to the figure, working from nude, draped, and clothed male and female models. A primary goal of the class is to develop the ability to create the human figure from imagination, based on intensive empirical study of the forms and structures of the human body from life. Although most of the work takes place in class, some outside study is required.

54-448 Figure Drawing II

Spring: 6 units

PRE-REQUISITES: If taking Figure Drawing II, both semesters of Figure Drawing I FOR: Costume Majors have priority, then Design Majors. First experience should be in Zamborsky section. DESCRIPTION: This year-long course explores the realistic and expressive depiction of the human form primarily in two dimensional media. Working primarily from the live model, exercises will be undertaken that address gesture, proportion, movement, anatomy and structure, composition and expressive form. Students will experience a variety of media and formal approaches to the figure, working from nude, draped, and clothed male and female models. A primary goal of the class is to develop the ability to create the human figure from imagination, based on intensive empirical study of the forms and structures of the human body from life. Although most of the work takes place in class, some outside study is required.

54-451 Lighting Design II

Fall: 9-21 units

Students explore design in different genres that include opera, dance, large scale live entertainment events, television and architectural lighting. Focus is also given to preparation in the business aspects of developing a professional career. Prerequisites: 54349 and 54350 and 54352

54-452 Lighting Design II

Spring: 9-21 units

Students explore design in different genres that include opera, dance, large scale live entertainment events, television and architectural lighting. Focus is also given to preparation in the business aspects of developing a professional career. This is a continuation of the fall semester. Prerequisites: 54451

54-453 Production Management Workshop I

Fall: 3 units

Fall: Variable Units Investigates the organization, planning and interpersonal skills required to successfully manage a live theatrical production. Course is discussion based on 1) participants experience in laboratory productions in the School of Drama, 2) current practical examples of experiences of professional production managers, and 3) contemporary management texts. Topics covered include: Budgeting, Scheduling, Communication, and Project Management. Permission of instructor required.

54-456 Production Management Workshop

Spring: 3 units

Spring: Variable Units Investigates the organization, planning and interpersonal skills required to successfully manage a live theatrical production. Course is discussion based on 1) participants experience in laboratory productions in the School of Drama, 2) current practical examples of experiences of professional production managers, and 3) contemporary management texts. Topics covered include: Budgeting, Scheduling, Communication, and Project Management. Permission of instructor required.

54-457 Directing: Production IV

Fall: 12 units

SENIOR DIRECTING PROJECT: This is a 90-minute, public, fully-designed presentation directed by a 4th-Year Directing student with the following goals: to publicly realize a playwright's purpose for a live audience; to tell an entire theatrical story with a beginning, progression & ending; to work as a team with actors & design team to shape a cohesive & coherent theatrical presentation; to extend practical understanding of Theatre as a collaborative process; to synthesize & apply prior studies at Carnegie Mellon

54-458 Directing: Production IV

Spring: 10 units

SENIOR DIRECTING PROJECT: This is a 90-minute, public, fully-designed presentation directed by a 4th-Year Directing student with the following goals: to publicly realize a playwright's purpose for a live audience; to tell an entire theatrical story with a beginning, progression & ending; to work as a team with actors & design team to shape a cohesive & coherent theatrical presentation; to extend practical understanding of Theatre as a collaborative process; to synthesize & apply prior studies at Carnegie Mellon

54-461 Production Preparation IV

Fall: 15 units

Participation in School of Drama productions, usually in supervisory roles in design or production. Pre-requisites/Co-requisites: 54-361 & 362 Prerequisites: 54361 and 54362

54-462 Production Preparation IV

Spring: 15 units

Participation in School of Drama productions, usually in supervisory roles in design or production. Pre-requisites/Co-requisites: 54-361 & 362 Prerequisites: 54361 and 54362

54-475 Theatre Management

Fall: 6 units

Survey of management practices and principles as applied to the performing arts. Investigation of selected problems typical of those facing the arts administrator.

54-477 Technical Design II

Fall: 9 units

Required for all senior undergraduate Technical Direction students. This "capstone" course is the second semester of a sequence requiring application of concepts from earlier courses including Standard Scenery Construction, Production Planning, Structural Design, Stage Machinery Design and Technical Design 1. This is a project-based course requiring weekly presentation of solutions to various "unusual" technical challenges, drawn from actual production experiences. Thorough documentation (shop drawings, budgets, build schedules, etc.) is a requirement for each project. Prerequisites: 54378

54-480 Music Reading for Drama Technicians

Spring: 3 units

This class gives the basics of music theory, musical terminology and score reading. Students focus on the difference in various musical scores, ie. piano/vocal, full, hand written scores. Students are guided in classroom listening which a wide variety of music including, opera, musical theatre, ballet, and choral/orchestra works.

54-483 Growing Theatre Community Outreach

Fall: 9 units

Growing Theater engages students and mentors in the development of a collaborative theater experience. Through Mentor Role Modeling, Growing Theater uses drama as a medium to expose at risk population of fifth graders from a local school to a supportive learning environment that is shared, creative, confident, patient and respectful. Growing Theater Mentors will broaden students' personal and professional outlooks by guiding through them this theatrical process. The resulting play is performed in May at CMU.

54-484 Growing Theatre Community Outreach

Spring: 9 units

Growing Theater engages students and mentors in the development of a collaborative theater experience. Through Mentor Role Modeling, Growing Theater uses drama as a medium to expose at risk population of fifth graders from a local school to a supportive learning environment that is shared, creative, confident, patient and respectful. Growing Theater Mentors will broaden students' personal and professional outlooks by guiding through them this theatrical process. The resulting play is performed in May at CMU.

54-487 Dramaturgy: Production IV

Fall: 12 units

Working as a production dramaturg for a season show or a professionally-produced show at a LORT or similarly-ranked theatre in the US or abroad, in senior year.

54-488 Dramaturgy: Production IV

Spring: 12 units

Working as a production dramaturg for a season show or a professionally-produced show at a LORT or similarly-ranked theatre in the US or abroad, in senior year.

54-489 Dramaturgy: Internship

Fall: 9 units

Professional internship with a dramaturg at a LORT or similarly-ranked theatre in the US or abroad.

54-490 Dramaturgy: Internship

Spring: 9 units

Professional internship with a dramaturg at a LORT or similarly-ranked theatre in the US or abroad.

54-493 Business of Acting

Fall: 4 units

The course introduces the (advanced) actor to various aspects of the professional world. Emphasis is placed on the audition and interview process for casting directors, talent agents and personal managers. Each student will present either an individual or small group project chosen from a wide ranging list of topics which include performers unions, various production contracts, New York and regional theater season,s professional publications and web sites. Occasional tests are administered on the subject of current Broadway and Off-Broadway seasons.

54-494 Business of Acting

Spring: 3 units

The course introduces the (advanced) actor to various aspects of the professional world. Emphasis is placed on the audition and interview process for casting directors, talent agents and personal managers. Each student will present either an individual or small group project chosen from a wide ranging list of topics which include performers unions, various production contracts, New York and regional theater season,s professional publications and web sites. Occasional tests are administered on the subject of current Broadway and Off-Broadway seasons.

Prerequisites: 54301 and 54302

54-500 Voice Lab

Fall and Spring: 5 units

Singing Voice based on speech-level and classical singing techniques, required of all Musical Theatre Majors Lessons are private, for the duration of one hour per week. Voice Lab combines all students of Musical Theatre in a one-hour performance class, where repertoire is performed for faculty and students alike. Training is progressive, with each semester building on the vocal mastery achieved from the previous semester. Repertoire spans from classical to rock, but with an emphasis on songs extracted from the American Musical Canon.

54-505 Ear Training

Fall: 6 units

Ear Training for sound designers and audio technologists. Introduction and development of skills and techniques for discerning, measuring and expressing the physical qualities of sound with accuracy and sensitivity. Topics include recognizing frequencies (1/3 octave and dual-octave) and analyzing effects and processing (pitch, amplitude, time domain and timbral). Prerequisites: declared School of Drama sound design major or minor

54-509 Production Sound Design

Fall: 9 units

Intensive course exploring the theory, art and technology of large scale sound system design for entertainment, specifically live theater productions. Prerequisites: 54-666 Production Audio

54-511 Costume Crafts I

Fall: 6 units

For: First Year Costume Design Graduate students. Graduate and Declared Undergraduate Costume Design Students will have priority for remaining spaces in the class. Students will learn the technique of fabric dyeing and painting using a variety of methods, chemicals, products, and processes. Students will gain facility in the use of the equipment and machinery involved, as well as developing stronger skills in color theory. Safe use and practices will be covered to instill good habits.

54-525 Electrics Seminar

Fall: 3-15 units

Course content includes advanced techniques in the management of a lighting department and continued practical application of the same. Class meetings will be in a seminar format as well as individual sessions with the instructor. An assignment on a School of Drama production is an integral part of the course. Prerequisites: 54-368

54-527 Automated Lighting Workshop

Fall: Mini Session - 3-15 units

Students will explore the operation of various automated lighting equipment in a hands-on format. An assignment on a School of Drama production may be included as part of the course. This course is repeatable. Prerequisites: 54-351

54-666 Production Audio

Spring: 6 units

Introduction to the technology and theory of sound systems, specifically those as they are utilized in theatrical and other live entertainment productions.

Music**57-008 Vocal Master Class I**

Fall and Spring: 0 units

This is a group coaching class for freshmen voice majors.

57-009 Vocal Master Class II

Fall and Spring: 0 units

This is a group coaching class for sophomore voice majors.

57-101 Introduction to Music Technology

Fall and Spring: Mini Session - 6 units

This course gives an overview of music technology through practical information and several hands-on projects. Concepts such as MIDI and digital audio are introduced and specific topics are covered in detail including sequencing, music notation, digital recording, mixing, and production. Throughout the course, students are required to complete several projects and create musical compositions in styles of their own choosing. The student is not graded on the "musicality" of these compositions, but instead on how well they meet the stated project goals by correctly using specific equipment and/or computer programs.

57-102 Finale

Spring: 6 units

This course provides hands-on and in-depth instruction of the Finale music notation program by Coda Music Software. Students will learn how to efficiently use the various notation tools that Finale has to input, edit, and manipulate music. MIDI input, playback, and transcription will also be covered to allow students to quickly notate and hear their music. The goal is to create professional-looking printed scores and parts in a variety of styles from Classical to Contemporary. A basic knowledge of music notation is required.

57-111 Movement and Dance I

Fall: 3 units

The CMU School of Music movement curriculum is designed to expose students to various styles and genres of contemporary and traditional forms of dance and movement. Students will increase their technical proficiency and personal artistry in dance in order to expand their physical skills as vocal performance artists. Courses will: Improve students' posture and strength, Increase proficiency in dance vocabulary, Increase ability to recognize, interpret and execute choreography, movement and staging direction, Enhance kinesthetic awareness and physical confidence and Improve overall health. With a focus on creativity and expression in movement, these courses concentrate on using the body as a tool in the creative process. Throughout "Movement and Dance I - IV", courses will include movement fundamentals, modern dance, ballet, partnering, dance composition/improvisation; as well as mini-courses in dance forms which can include stage combat, Flamenco dance, pilates and ballroom dance.

57-112 Movement and Dance II

Spring: 3 units

The CMU School of Music movement curriculum is designed to expose students to various styles and genres of contemporary and traditional forms of dance and movement. Students will increase their technical proficiency and personal artistry in dance in order to expand their physical skills as vocal performance artists. Courses will: Improve students' posture and strength, Increase proficiency in dance vocabulary, Increase ability to recognize, interpret and

execute choreography, movement and staging direction, Enhance kinesthetic awareness and physical confidence and Improve overall health. With a focus on creativity and expression in movement, these courses concentrate on using the body as a tool in the creative process. Throughout "Movement and Dance I - IV", courses will include movement fundamentals, modern dance, ballet, partnering, dance composition/improvisation; as well as mini-courses in dance forms which can include stage combat, Flamenco dance, pilates and ballroom dance.
Prerequisites: 57111

57-150 Basic Harmony I

Fall: 9 units

This course deals with common-practice harmony. It includes triads and their inversions, tonality and modality, non-harmonic tones, cadences, and the basic concepts of modulation. It includes work on fundamentals for inexperienced students.

57-151 Principles of Counterpoint

Fall: 6 units

This course explores the development of Western music composed with multiple independent parts. The first half of the course traces the history of part-writing from medieval organum through the late twentieth-century. The second half examines, across several musical styles, specific contrapuntal techniques such as imitation and ground bass forms. Assignments include both writing exercises and analysis projects.

Prerequisites: 57152 or 57155

57-152 Harmony I

Fall: 6 units

This course deals with common-practice harmony. It includes triads and their inversions, tonality and modality, non-harmonic tones, cadences, and the basic concepts of modulation.

57-153 Harmony II

Spring: 6 units

This course is a continuation of the study of common practice harmony, exploring dissonant and chromatic harmony.

Prerequisites: 57150 or 57152 or 57155

57-155 Advanced Harmony I

Fall: 6 units

This course deals with common-practice harmony. It includes triads and their inversions, tonality and modality, non-harmonic tones, cadences, and the basic concepts of modulation. It includes work on advanced concepts for experienced students.

57-156 Advanced Harmony II

Spring: 6 units

This course is a continuation of the study of common practice harmony, exploring dissonant and chromatic harmony. It includes work on advanced concepts for experienced students.

Prerequisites: 57155

57-161 Eurhythmics I

Fall: 3 units

Dalcroze Eurhythmics is a unique approach to music learning based on the recognition that meaningful rhythmic movement experience, associated with ear-training and improvisation, reinforces understanding of music concepts, enhances musicianship, and focuses awareness on the physical demands of artistic performance. All concepts are experienced in a musical context. Rhythm reading, notation, analysis, and improvisation are integral to the course. Eurhythmics I covers basic binary and ternary metric units and rhythm patterns in relation to these metric units within simple and compound meters.

57-162 Eurhythmics II

Spring: 3 units

Eurhythmics II introduces combinations of binary and ternary metric units, mixed meters, changing meters, and notation and performance of cross-rhythms.

Prerequisites: 57161

57-163 Eurhythmics III

Fall: 3 units

Eurhythmics is a unique approach to music learning developed by the Swiss composer and educator Emile Jaques-Dalcroze (1865-1950). Dalcroze discovered that meaningful rhythmic movement experiences away from their instrument allows students to focus awareness on the physical demands of artistic performance while demonstrating knowledge and understanding of the expressive/interpretive as well as the theoretical aspects of music. Sight reading, conducting, notation, analysis and improvisation are

integral to the course. Eurhythmics III Course Content: Divisive vs Additive rhythm, Metric transformation, Irregular subdivisions of metric units, Cross rhythms of 3 against 4, 3 against 5, 4 against 5.
Prerequisites: 57162

57-164 Eurhythmics IV

Spring: 3 units

Eurhythmics is a unique approach to music learning developed by the Swiss composer and educator Emile Jaques-Dalcroze (1865-1950). It is a process for awakening, developing and refining innate musicality through rhythmic movement, ear training and improvisation. Through rhythmic movement, students demonstrate knowledge and understanding of the expressive/interpretive as well as the metrical/structural aspects of music. Sight reading, conducting, notation, analysis and improvisation are integral to the course. Eurhythmics IV Course Content: More complex rhythmic problems encountered in composed music, Changing meters and changing metric units within a composition, Rhythm reading of patterns using small note values, Messiaen rhythm techniques.

Prerequisites: 57163

57-171 Introduction to Music Technology (self-paced)

Fall and Spring: Mini Session - 6 units

This course gives an overview of music technology through practical information and several hands-on projects. Concepts such as MIDI and digital audio are introduced and specific topics are covered in detail including sequencing, music notation, digital recording, mixing, and production. Throughout the course, students are required to complete several projects and create musical compositions in styles of their own choosing. The student is not graded on the "musicality" of these compositions, but instead on how well they meet the stated project goals by correctly using specific equipment and/or computer programs. This is a self-paced version of 57-101. Material will be covered during weekly class sessions, though students are expected to make time in the evenings or weekends to work on their projects in either the MTC (MM119A) or some other cluster. Students with prior experience may pass out of certain classes and projects by providing teacher with equivalent work (pending teacher approval). In addition to the required projects, there is a final exam which is administered during the last class session.

57-173 Survey of Western Music History

Fall: 9 units

This course surveys the development and contexts European art music and its global adaptation. While keeping in view the chronology from Gregorian chant to the present, this survey emphasizes key personalities and issues, particularly issues relating to period style and interpretive decisions in performance.

57-180 Basic Solfege I

Fall: 3 units

This course improves the student's ability to analyze music aurally and to sing at sight in traditional meters and tonalities using the "fixed do" system. Solfege is the integration of the three cognitive skills: reading music, hearing music, and writing what one hears. Section assignment is determined by a placement test given at the time of the audition or prior to the start of classes. It includes work on fundamentals for inexperienced students.

57-181 Solfege I

Fall: 3 units

This course improves the student's ability to analyze music aurally and to sing at sight in traditional meters and tonalities using the "fixed do" system. Solfege is the integration of the three cognitive skills: reading music, hearing music, and writing what one hears. Section assignment is determined by a placement test given at the time of the audition or prior to the start of classes.

57-182 Solfege II

Spring: 3 units

Continues 57-181 Solfege I.

Prerequisites: 57180 or 57181 or 57185

57-183 Solfege III

Fall: 3 units

Continues 57-182 Solfege II. Students are given assignments of classical music written in the treble, bass, soprano, alto, and tenor clefs. Writing consists of two-part contrapuntal dictations.

Prerequisites: 57182

57-184 Solfege IV

Spring: 3 units

Continues 57-183 Solfege III. Students learn to read atonal music and practice three-part contrapuntal dictations as well as harmonic dictations.

Prerequisites: 57183

57-185 Advanced Solfege I

Fall: 3 units

This course improves the student's ability to analyze music aurally and to sing at sight in traditional meters and tonalities using the "fixed do" system. Solfege is the integration of the three cognitive skills: reading music, hearing music, and writing what one hears. Section assignment is determined by a placement test given at the time of the audition or prior to the start of classes. It includes advanced work for experienced students and those with perfect pitch.

57-186 Advanced Solfege II

Spring: 3 units

Continues 57-185 Advanced Solfege I.

Prerequisites: 57185

57-189 Repertoire and Listening for Musicians I

Fall: 3 units

One of the most important ways of achieving musical excellence is to listen. In this course, students listen critically to essential music which has stood the test of time and to superior performances. This on-line course features listening and discussion in a virtual coffee shop atmosphere. 2-3 hours of listening per week. Midterm and final listening tests. Proficiency requirement for freshman music majors.

57-190 Repertoire and Listening for Musicians II

Spring: 3 units

One of the most important ways of achieving musical excellence is to listen. In this course, students listen critically to essential music which has stood the test of time and to superior performances. This on-line course features listening and discussion in a virtual coffee shop atmosphere. 2-3 hours of listening per week. This semester introduces full scores for chamber and orchestral music. Midterm and final listening tests. This course contains midterm and final listening tests. Proficiency requirement for freshman music majors. Other students admitted with instructor's permission.

57-191 Keyboard Studies

Fall and Spring: 3 units

All undergraduate music students are required to take four semesters of keyboard studies during their freshman and sophomore years. The emphasis of this course is to develop a practical keyboard facility, which includes keyboard theory and technique, sightreading, solo and ensemble repertoire, transposition, and a variety of creative activities such as harmonization and improvisation.

57-192 Keyboard Studies

Fall and Spring: 3 units

All undergraduate music students are required to take four semesters of keyboard studies during their freshman and sophomore years. The emphasis of this course is to develop a practical keyboard facility, which includes keyboard theory and technique, sightreading, solo and ensemble repertoire, transposition, and a variety of creative activities such as harmonization and improvisation.

Prerequisites: 57191

57-193 Skills of Accompanying I

Fall: 3 units

A required course for first year piano majors. The skills include sightreading, basic keyboard harmony, transposition, and improvised accompaniments for popular or musical theater songs from either a piano reduction or a lead sheet. The students participate in collaborative situations such as juries, recitals, and class presentations. The presentations are critiqued by the instructor and by other students.

57-194 Skills of Accompanying II

Spring: 3 units

Continues 57-193 Skills of Accompanying I.

Prerequisites: 57193

57-207 Secondary Studio

Fall: 3-9 units

Provides the opportunity for students to pursue study in a secondary instrument or area. By special permission only.

57-208 Secondary Studio

Spring: 3-9 units

Provides the opportunity for students to pursue study in a secondary instrument or area. By special permission only.

57-209 The Beatles

Intermittent: Mini Session - 6 units

This course will focus on the phenomenon of the Beatles. Their songs will be studied, with analysis of the musical and lyrical content and structural elements. What musical styles do the songs address? What were their musical influences? In what ways did their music change over the years? Also, the music's social context will be studied. Why were the Beatles so popular and influential? What exactly caused Beatlemania? How did the group form, grow, and end? The Beatles are the most famous rock group in history; the reasons for this are as much cultural as musical, and we'll study the two elements simultaneously. Open to all undergraduate students.

57-211 Movement and Dance III

Fall: 3 units

The CMU School of Music movement curriculum is designed to expose students to various styles and genres of contemporary and traditional forms of dance and movement. Students will increase their technical proficiency and personal artistry in dance in order to expand their physical skills as vocal performance artists. Courses will: Improve students' posture and strength, Increase proficiency in dance vocabulary, Increase ability to recognize, interpret and execute choreography, movement and staging direction, Enhance kinesthetic awareness and physical confidence and Improve overall health. With a focus on creativity and expression in movement, these courses concentrate on using the body as a tool in the creative process. Throughout "Movement and Dance I - IV", courses will include movement fundamentals, modern dance, ballet, partnering, dance composition/improvisation; as well as mini-courses in dance forms which can include stage combat, Flamenco dance, pilates and ballroom dance.

Prerequisites: 57112

57-212 Movement and Dance IV

Spring: 3 units

The CMU School of Music movement curriculum is designed to expose students to various styles and genres of contemporary and traditional forms of dance and movement. Students will increase their technical proficiency and personal artistry in dance in order to expand their physical skills as vocal performance artists. Courses will: Improve students' posture and strength, Increase proficiency in dance vocabulary, Increase ability to recognize, interpret and execute choreography, movement and staging direction, Enhance kinesthetic awareness and physical confidence and Improve overall health. With a focus on creativity and expression in movement, these courses concentrate on using the body as a tool in the creative process. Throughout "Movement and Dance I - IV", courses will include movement fundamentals, modern dance, ballet, partnering, dance composition/improvisation; as well as mini-courses in dance forms which can include stage combat, Flamenco dance, pilates and ballroom dance.

Prerequisites: 57211

57-220 English Diction

Fall: 3 units

This one semester course helps singers sing English songs from the Classical and Musical Theater repertoire with clarity, accuracy, ease, uniformity, and expressiveness; to illuminate meaning; and to improve tonal quality through diction.

57-221 Italian Diction

Fall: 3 units

A study of the fundamentals of Italian diction and development of legato vocal style through the analysis of grammatical usage, word construction, vowel colorization, and consonant articulation. Included are in-class performance evaluations, listening assignments, critiques, and private coachings.

57-222 French Diction

Fall: 3 units

This course is designed primarily for singers specializing in French Art Songs of the 19th and 20th centuries. It deals with the use of the International Phonetic Alphabet, its application to singing in French, the use of the liaison and the preparation of the text of a song or aria. One-third of the course is theory and two-thirds of the course is spent on application by performance with piano accompaniment.

57-223 German Diction

Fall: 3 units

In-depth study of German diction - development of legato vocal style in German through the analysis of grammatical usage, word construction, vowel colorization and consonant articulation. Included are in-class German diction evaluations, peer assessment, and emphasis on competency in using the International Phonetic Alphabet.

57-225 Contemporary Ensemble

Fall and Spring: 3 units

This ensemble performs the wide range of expressive media that composers have developed in our time. Programs include three categories of works: 1) compositions that can be called Twentieth Century classics because of the historical importance and the aesthetic influence they have had on our musical culture; 2) compositions written by student composers; and 3) compositions written by well-known composers that show new and original artistic points of view. The repertoire ranges from works for chamber ensemble to concert and chamber opera.

57-227 Jazz Ensemble

Fall and Spring: 3 units

These are Jazz Ensembles (Section A and Section B) which incorporate a comprehensive approach to Big Band performance and study. The music performed is drawn from all eras of big band repertoire with occasional programs of specific composers and genres. The Jazz Ensembles are carefully coordinated with the Jazz Performance Minor program, the Jazz Vocal Ensemble, and other major ensembles in order to challenge and prepare students for professional music career opportunities. Both ensembles perform on the regular School of Music concert series (2-3 shows per semester) and for on-campus events. Trips to festivals and performances at local venues as part of jazz concert series also occur. The "final exam" for this course is a performance at a local jazz club. Admission of undergraduate and graduate students is by competitive audition and placement is by the director. Grading is based on attendance, preparation, and consistent progress.

57-228 Chamber Music

Fall and Spring: Mini Session - 3 units

Through rehearsal, coaching, and performance, ensembles solve problems of intonation, balance, and interpretation.

57-230 Baroque Ensemble

Fall and Spring: 3 units

Carnegie Mellon Baroque is a performing ensemble of 15-25 players consisting of winds, strings and keyboard. Students in this ensemble explore the orchestral and chamber music of the 18th Century. The Ensemble performs on modern instruments, incorporating performance practice ideals of the Baroque era. Throughout the rehearsal process, students are encouraged to study original source materials and arrive at historically informed and musically satisfying performances.

57-231 Chamber Ensemble

Intermittent: Mini Session - 3 units

Provides an opportunity for students to play in small ensembles, advised by faculty coaches. The performers will develop effective rehearsal techniques, explore chamber music repertoire, deal with issues of intonation and balance, and arrive at interpretive conclusions that are stylistically sound, yet individualistic and creative.

57-232 Chamber Music (Guitar)

Fall and Spring: 3 units

Provides an opportunity for students to play in small ensembles, advised by faculty coaches. The performers will develop effective rehearsal techniques, explore chamber music repertoire, deal with issues of intonation and balance, and arrive at interpretive conclusions that are stylistically sound, yet individualistic and creative.

57-233 Sonatas

Fall and Spring: 3 units

This course focuses on coaching of performance groups with two members. It parallels Chamber Music, which focuses on coaching of performance groups with three or more members.

57-234 Performance for Composers

Fall: 3 units

This course is for composition majors who choose to fulfill the performance elective requirement in the junior year by completing an independent performance project in the fall semester. Examples of projects can include producing a recital of his/her compositions,

or pursuing other performing interests, such as writing music for a School of Drama production. Registration by composition faculty permission only.

57-236 Performance for Composers

Spring: 3 units

This course is for composition majors who choose to fulfill the performance elective requirement in the junior year by completing an independent performance project in the spring semester. Examples of projects can include producing a recital of his/her compositions, or pursuing other performing interests, such as writing music for a School of Drama production. Registration by composition faculty permission only.

Prerequisites: 57234

57-240 Acting I

Fall: 6 units

The basics of acting will be established throughout the first year following the guideposts described in Audition, by Michael Shurtleffis. Structured improvisations, monologues, scene work, songs, and arias will provide a platform for the development of stage presence and effective communication. Each semester will finish with a group project that provides an opportunity for the students to begin to work together as a cast.

57-241 Acting II

Spring: 6 units

Continues 57-240 Acting I.

Prerequisites: 57240

57-253 Renaissance Counterpoint

Intermittent: 6 units

In this course the student will study how to write vocal counterpoint using the classic "species" approach, based on the style of Renaissance masters Palestrina, Lassus, and Victoria. The latter part of the course will extend the study to instrumental music of the 16th century, and explore the development of chromaticism in avant-garde composers of the time. Reading about and listening to Renaissance music and composers will be included as background context for the theory work. Daily writing exercises in the first part of the course will lead to a term project producing a performable piece of music. This course is designed for composers (both for writing technique and college teaching preparation), theory minors, early music lovers, choral singers and conductors, church musicians, and anyone who wants to sharpen their writing skills. Students must be able to demonstrate competence in reading treble and bass clef, and intervals. This course is currently offered during the fall semester in even-numbered years.

Prerequisites: 57152 or 57155

57-254 Counterpoint in 18th Century Composition

Intermittent: 6 units

In this course the student will study how to write two-part counterpoint within the harmonic framework of 18th-century instrumental music. The focus of study will be J.S. Bach's inventions, and writing will be directed towards composing several complete inventions in that style. The integration of tonal writing skills in harmony and counterpoint will prepare the student for Fugue (57-265). This course is designed for composers, theory minors, Bach lovers, and anyone who wants to seriously sharpen their tonal writing skills. This course is currently offered during the fall semester in odd-numbered years.

Prerequisites: 57153 or 57156

57-257 Orchestration I

Fall: 6 units

This is an introductory course for all music majors and required for sophomore composition majors. The characteristics of each instrument of the orchestra are studied thoroughly. Orchestral textures from the classics to contemporary music are studied and analyzed.

Prerequisites: 57152 or 57155

57-258 20th Century Techniques

Spring: 6 units

This course is open to all music majors and required for sophomore composition majors. The most important techniques from Debussy to the present will be reviewed in terms of melody, harmony, and form. Tonality, serialism, and aleatoric devices will be studied.

Compositional techniques of the 20th Century are put into perspective and compared with other developments in the arts. The class is conducted as an open forum in which discussions are encouraged.

Prerequisites: 57153 or 57156

57-271 Orchestration II

Fall: 6 units

This course is designed for junior composition majors; others are admitted by permission. The students will analyze music from the Classical to Avant-Garde and use the knowledge acquired to orchestrate piano scores in the appropriate style. Style, practicality, color, and imagination are encouraged.

Prerequisites: 57257

57-272 Orchestration III

Spring: 6 units

Continues 57-271 Orchestration II and combines orchestration and composition.

Prerequisites: 57271

57-273 Piano Pedagogy I

Fall: 6 units

This course offers an historical overview of piano pedagogy including its significant developments over the past forty years. Topics covered include beginning piano techniques, the sequencing of concepts and materials, common problems among beginning pianists, practicing, motivation, and parental involvement. Current representative beginning piano methods will be surveyed.

57-274 Piano Pedagogy II

Spring: 6 units

Beyond the beginning years: this course covers piano pedagogy of intermediate and early advanced level students. Topics include "What is style?" and "What is a good piece?" Standard literature and technical development repertoire lists will be studied. The business of piano teaching and the instruction of college keyboard skills for non-piano majors will be discussed.

Prerequisites: 57273

57-275 Piano Pedagogy III

Fall: 6 units

Continuation of 57-274. Intermediate literature, analysis, teaching, and performance will be covered.

Prerequisites: 57274

57-276 Piano Pedagogy IV

Spring: 6 units

Continuation of 57-275. Early advanced literature, analysis, teaching, and performance will be covered.

Prerequisites: 57275

57-283 Music History I

Fall: 9 units

This course will be a historic overview of each period of Western European art music and in-depth analysis of representative musical genres and forms. The first semester will begin with the birth of Opera and the Baroque era and continue through the early works of Beethoven. We will then analyze the genres/forms of the Middle Ages and Renaissance.

Prerequisites: 57173 Corequisites: 57-289

57-284 Music History II

Spring: 9 units

This course will be a historic overview of each period of Western European art music and in-depth analysis of representative musical genres and forms. The second semester will begin with the middle period works of Beethoven and will continue chronologically through the major composers, styles, and forms of the 19th and 20th centuries.

Prerequisites: 57283 Corequisites: 57-290

57-289 Repertoire and Listening for Musicians III

Fall: 1-3 units

This is a continuation of the School of Music's four-semester listening curriculum. Students listen critically to essential music which has stood the test of time and to superior performances. This semester's repertoire includes units focusing on contrapuntal masterpieces from the Middle Ages through 20th Century, and further builds score-reading experience. This on-line course features listening and discussion in a virtual coffee shop atmosphere. 2-3 hours of listening per week. Midterm and final listening tests. Proficiency requirement for sophomore music majors. Other students admitted with instructor's permission. Repertoire and Listening for Musicians I and II are not prerequisites.

57-290 Repertoire and Listening for Musicians IV

Spring: 1-3 units

This is the culmination of the School of Music's four-semester listening curriculum. Students listen critically to essential music which has stood the test of time and to superior performances.

Highlights of this semester's repertoire include units on Middle and Late Beethoven as well as a decade-by-decade survey of the 20th Century. This on-line course features listening and discussion in a virtual coffee shop atmosphere. 2-3 hours of listening per week. Midterm and final listening tests. Proficiency requirement for sophomore music majors. Other students admitted with instructor's permission. Repertoire and Listening for Musicians I-III are not prerequisites.

57-291 Keyboard Studies

Fall and Spring: 3 units

All undergraduate music students are required to take four semesters of keyboard studies during their freshman and sophomore years. The emphasis of this course is to develop a practical keyboard facility, which includes keyboard theory and technique, sightreading, solo and ensemble repertoire, transposition, and a variety of creative activities such as harmonization and improvisation.

Prerequisites: 57192

57-292 Keyboard Studies

Fall and Spring: 3 units

All undergraduate music students are required to take four semesters of keyboard studies during their freshman and sophomore years. The emphasis of this course is to develop a practical keyboard facility, which includes keyboard theory and technique, sightreading, solo and ensemble repertoire, transposition, and a variety of creative activities such as harmonization and improvisation.

Prerequisites: 57291

57-293 Keyboard Studies Test (Degree)

Fall and Spring: Mini Session - 0 units

This is the keyboard proficiency test which is a requirement for all undergraduate music majors who are not piano majors.

57-294 Beginning Piano Test

Fall and Spring: Mini Session - 0 units

This is the keyboard proficiency test which is a requirement for all music performance, music composition, music technology, and music theory minors.

57-300 Pipe and Drum Band

Fall and Spring: 3 units

The Pipe Band at Carnegie Mellon is a competitive Grade 3 band in the Eastern United States Pipe Band Association. The band competes at various Scottish festivals and Highland Games during the school year. The band also performs at university activities throughout the year. These include Convocation, Homecoming, Spring Carnival, and Commencement. Other engagements are Spring Concert at CMU and the St. Patrick's Day Parade in Pittsburgh. The band has also played as an opening act for the Pittsburgh Steelers and a Rod Stewart concert. Pipers receive a half hour individual lesson with Alasdair Gillies weekly. Drummers are taught weekly by Larry Allen.

57-301 Bagpipe History

Intermittent: 3 units

This course covers all types of bagpipe music, including Ceol Mor and Ceol Beag, and studies the prominent composers from MacCrimmon to the present day. Students compose their own material in all time signatures commonly used. The course covers Piobaireachd, Marches, Strathspeys, Reels, Hornpipes, and Jigs, as well as harmony and the ability to write out tunes from repetitive listening.

57-302 Bagpipe Construction

Intermittent: 3 units

This course is an in-depth study of Piobaireachd construction, including Primary, Secondary, Tertiary Types A & B, Supplementary Types A & B, and Irregular. The course covers the different patterns in Light Music construction. Students also study the makeup of Pipe Band Medleys and repertoire for competition versus concert.

Prerequisites: 57307

57-303 Bagpipe Literature and Repertoire

Intermittent: 3 units

This course will cover the origins of the bagpipe and Piobaireachd, bagpipe music in competition, military, and dance. We will also cover major piping competitions, famous bagpipe players, and piping today.

57-304 Bagpipe Maintenance

Intermittent: 3 units

All aspects of bagpipe maintenance are covered in this course, from basic hemping and tying in bags to reeds set-up and manipulation. The course includes study of all types of reeds, cane and synthetic, as well as drone and chanter, and recognition of pipemakers' patterns and distinctive hallmarks.

57-305 Bagpipe Reedmaking

Intermittent: 3 units

This is a hands-on course where the student learns how to make pipe chanter reeds by the traditional method of gouging, shaping, and tying up. This course follows 57-304, Bagpipe Maintenance. Further analysis of chanter and drone reeds will be covered also. Prerequisites: 57304

57-306 World Music

Fall: 6 units

An exploration of the diversity and complexity of music from around the world. The class will have three sections: 1. Classical music from India, Iran, Indonesia, and Asia; 2. Native and folk music from Africa, Europe, Australia, and the Americas; 3. The influence of world music on Western classical music. This class will include some reading, listening to CDs, watching videos, and papers and/or presentations. If time permits, there will be special musical activities and invited guests.

57-307 Bagpipe Theory

Intermittent: 3 units

This course prepares students for 57-302, Bagpipe Construction. All aspects of Bagpipe Theory are covered, including time signatures, grand staff, musical rudiments, musical terms and definitions, and writing of simple tunes from memory.

57-308 Bagpipe Advanced History

Intermittent: 3 units

This course is an in-depth study of the origins of the bagpipe, including the oral tradition, the Hereditarypipers and their teachings, piping in the military, prominent teachers, and a study of the Tree of Piping dating from MacCrimmon to the present day.

57-310 Bagpipe Advanced Literature and Repertoire

Intermittent: 3 units

This course prepares students who have covered all other courses for the Graduate Exam from the Institute of Piping in Scotland. It covers all aspects of theory, history, and practical ability. An in-depth paper should also be prepared by the students in this course on a piping topic of their choice.

57-319 Jazz Piano I

Fall and Spring: 3 units

This is a small group lesson for music majors and jazz performance minors.

57-320 Jazz Piano II

Fall and Spring: 3 units

Continues 57-319 Jazz Piano I. This is a small group lesson for music majors and jazz performance minors. Prerequisites: 57319

57-328 Jazz Chamber Music

Fall and Spring: 3 units

In this course, the ensemble creates two sets (a set being 5-6 tunes) of arranged tunes. Standards and non-standard tunes of the jazz repertoire are chosen by the director with input from the members. New compositions by members may be played at the discretion of the director. Students should have a background in playing jazz and be able to read from "fakebooks" available from the school library. Each week, 1-3 tunes are arranged and rehearsed. At the end of the course, the "final exam" consists of a two set performance at a local jazz club. This course fulfills, in part, the requirements for the jazz minor. Non-music majors and minors are admitted by appointment with the director. Undergraduate and graduate students are eligible for this course. Prerequisites: 57450

57-329 Beginning Piano for Minors

Fall and Spring: 3 units

This is a small group lesson for music performance, music composition, music technology, and music theory minors who cannot pass the required beginning piano test.

57-330 Beginning Piano for Minors

Spring: 3 units

This is a small group lesson for music performance, music composition, music technology, and music theory minors who cannot pass the required beginning piano test.

57-331 Principles of Education

Fall: 9 units

This course introduces students to the art and science of being an educator. Content includes views of the academic and social structure of the school, physiological & social characteristics of learners that influence instruction, widely recognized research on learning & teaching, and appropriate & effective class preparation and teaching strategies.

Prerequisites: Corequisites: 57-608

57-332 Introduction to Conducting

Fall: 6 units

This course develops the basic skills needed to conduct instrumental ensembles or a small orchestra. It is primarily focused on conducting technique, body language and body coordination and communication. It also deals with learning and translating an instrumental or orchestral score into actual music. The goal is to achieve a clear and communicative technique upon which an artistic interpretation can be built. The student works periodically with a pianist or a small chamber ensemble.

57-333 Band and Choral Arranging

Spring: 6 units

This course presents basic techniques of arranging music for elementary and secondary school choral and instrumental ensembles. Instruments and voices are reviewed for best scoring properties and systematic aural & visual score analyses of repertoire are used to reveal various approaches to scoring ensemble sound. Prerequisites: 57153

57-334 Fundamentals of Marching Band

Fall: 3 units

A marching band, due to its visibility and high degree of student involvement, is an integral part of secondary school music programs. The well-schooled music education graduate must have knowledge of this unique form of music performance. This course, designed primarily for those seeking a career in teaching, will accommodate students with no experience and others who have participated in marching band. Among the many areas of concentration will be: philosophy, show charting, marching fundamentals and commands, logistical awareness, and budget formulation. Observation of and active assistance with Carnegie Mellon Kiltie Band will be part of the course content.

57-336 Instrumental/Choral Conducting

Spring: 6 units

This course is a continuation of Introduction to Conducting. The course offers a more detailed conducting technique, adding those subjects related to choral conducting. This is followed by the study and the analysis of interpretation from the point of view of the conductor and ends stressing a set of important practical items, including the psychological attitude and the leadership a conductor must develop as well as the organization and achievement of a fruitful rehearsal technique. The students work periodically with a pianist, a soloist or a chamber ensemble on traditional works and on their own compositions in the case of composition majors. Prerequisites: 57332

57-337 Sound Recording

Fall and Spring: Mini Session - 6 units

This course centers around the recording studio in the School of Music: how the studio works, and how to record various types of music, including classical music, using the recording studio and Kresge Recital Hall, which has audio and video links to the recording studio. The method of instruction is to learn by doing, and the goal, from the very first session, is to achieve professional-sounding results. Equipment includes a complete 24-track Pro-Tools system, professionally designed control room that can accommodate up to 24 people, outboard preamps and other gear, and an interesting array of microphones. All recording is direct to hard disc.

57-338 Sound Editing and Mastering

Fall and Spring: Mini Session - 6 units

The raw recording is just the first step in the process of creating a professional finished audio product. "Editing" is the art of piecing together different takes to make one final 'good take.' "Mastering" is the art of polishing the 'good take' to perfection--balancing all the instruments and tracks, adding special effects, setting final levels. If 'recording' seems like an high-energy activity--involving engineers,

musicians, producers--'editing and mastering' are the necessary counterparts--long tedious hours of solitary confinement honing the skills of the mastering engineer. Those taking this course are expected to have significant music skills: actively playing a musical instrument (or composition), and/or the ability to read a piano score at the least, and a full orchestra score from any recent century, including our own, at the most. Class attendance is essential; work outside of class is necessary.
Prerequisites: 57337

57-339 Acting III

Fall: 6 units

This course will build upon the foundation laid in the first year, with a more concentrated look at scene work, an audition workshop that focuses on cold readings as well as monologues, and a character-development project that works to identify specific issues that inhibit freedom on stage. More in-depth work on songs and arias will lead into a musical scene project. The semester will close with a classical text project in which the students will work with verse.
Prerequisites: 57241

57-340 Acting IV

Spring: 6 units

Continues 57-339 Acting III.

Prerequisites: 57339

57-347 Electronic and Computer Music

Fall: 6 units

This course builds on the concepts learned in Introduction to Music Technology (57-101) and gives added knowledge in the areas of composition using digital and analog devices as well as various computer programs. Building computer models of both analog and digital synthesizers as well as drum machines, loop players and various other sound processing effects will be covered in detail. Students will be required to produce several projects throughout the course demonstrating their understanding of various concepts in electronic music. More emphasis is placed on the overall quality of the end musical product than in 57-101 in order to prepare students for music production in a professional setting.
Prerequisites: 57101 or 57171

57-349 Supervised Theory Teaching

Fall and Spring: 6 units

This course provides teaching skills in theory for students who have already completed the theory program at Carnegie Mellon University or who have demonstrated theory competence. The students will attend all sessions of the assigned theory class and will assist the professor by correcting homework, delivering a short lecture, developing a class syllabus and tutoring individual students. The work is done under direct supervision and advice from the regular professor who is always present in the class. Enrollment limited to a maximum of two students per class.

57-350 Dalcroze Piano Improvisation

Fall and Spring: 3-6 units

These courses are required for candidates in the Dalcroze Certification program. They are designed to develop keyboard improvisation skills necessary for teaching Eurhythmics.

57-351 Dalcroze Piano Improvisation

Fall and Spring: 3-6 units

These courses are required for candidates in the Dalcroze Certification program. They are designed to develop keyboard improvisation skills necessary for teaching Eurhythmics.

Prerequisites: 57350

57-352 Dalcroze Piano Improvisation

Fall and Spring: 3-6 units

These courses are required for candidates in the Dalcroze Certification program. They are designed to develop keyboard improvisation skills necessary for teaching Eurhythmics.

Prerequisites: 57351

57-353 Dalcroze Piano Improvisation

Fall and Spring: 3-6 units

These courses are required for candidates in the Dalcroze Certification program. They are designed to develop keyboard improvisation skills necessary for teaching Eurhythmics.

Prerequisites: 57352

57-355 Secondary Guided Teaching

Spring: 3 units

This course enables students to apply instructional strategies in local secondary school music classes. School visits provide opportunities to work with band, choral, & orchestral ensembles and

general music classes. Seminar discussions with the cooperating teachers familiarize students with both school-wide and classroom management issues that affect teaching, learning, motivation, and the administration of music programs.

Prerequisites: 57332 and 57336 and 57356 and 57360 and 57361 and 57362 and 57363 and 57375 and 57607 Corequisites: 57-376

57-356 Elementary Guided Teaching

Fall: 3 units

This is the second level of field experience in the public schools.

This course provides for observation and closely supervised teaching experiences with elementary age children in a school setting.

Corequisites: 57-375

57-359 Career Strategies for Musicians

Intermittent: Mini Session - 3 units

This course will assist students in developing the necessary expertise and materials to transition successfully from music student to professional musician. Four major areas will be covered: 1.) The multifaceted activities of today's professional musicians, individual assessments to determine strengths and challenges related to these activities, and strategies for addressing challenging areas; 2.) Developing promotional materials for entrepreneurial and salaried opportunities. Entrepreneurial materials include business cards, letterhead, photo, bio, performance resume, email list, press release, flyers, grant proposals, demo CD and website. Salaried materials include an employment resume and cover letter; 3.) Self-employment considerations, including budgeting, taxes, health insurance, and unions; and, 4.) Communications, including handling auditions, introducing pieces, introducing group members, and pitching ideas. You have the talent, determination, and work ethic to succeed. Now learn the marketing, business and communications skills to close the gap.

57-360 Brass Methods

Fall: 3 units

This music education course develops basic brass playing and teaching techniques for beginning and intermediate instrument classes. The course includes training in beginning band program design, aural & visual diagnosis of individual and ensemble playing problems, and methods of accelerating music reading independence in young players.

57-361 Percussion Methods

Fall: 3 units

This class gives the non-percussion major a background in the fundamentals of teaching percussion. The main focus of the course is snare drum. The students spend most of their time learning the basic concepts of beginning snare drum so they will be prepared to teach beginning students of any grade level. Much time is devoted to proper stance, grip, and stroke in order to insure a good foundation for a beginning student. Also covered are the various mallet instruments, timpani, and all small hand percussion. Students will learn about purchasing proper equipment for the various levels of learning in common school programs.

57-362 Woodwind Methods

Spring: 3 units

This music education course develops basic woodwind playing and teaching techniques for beginning and intermediate instrument classes. The course includes training in beginning band program design, aural & visual diagnosis of individual and ensemble playing problems, and methods of accelerating music reading independence in young players.

57-363 String Methods

Spring: 3 units

String Methods prepares music educators for work in the public schools. A major portion of class time will be applied to violin and cello techniques. Upon completion of the course, the student will be expected to demonstrate the technical skills of a second year beginning string student. Students will also be introduced to various method books, string supplies, and repairs.

57-374 Music in the Urban School

Fall and Spring: 9 units

This course will involve workshops with nationally known instructors in eurhythmics, world drumming, contemporary popular music, and classroom management. The course will require attendance at workshops, classroom observations and closely supervised teaching experiences. Schools involved are all inner city schools with a poverty level of 75% or above. This course is offered as the result of a grant received from the Federal Department of Education by the School of Music, the Pittsburgh Public Schools, and the Wilkinsburg School District.

57-375 Music in the Elementary School

Fall: 6 units

This course is designed to provide a philosophical background for teaching music in the elementary school and to provide a variety of pedagogical techniques, which are essential when teaching music from Preschool through Grade 6.

Prerequisites: 57331 Corequisites: 57-356

57-376 Music in the Secondary School

Spring: 6 units

This course covers a variety of topics related to the development and the management music programs in secondary schools. Emphasis is placed on the leadership, classroom management, general music & performance course content, and routine administrative planning.

Prerequisites: 57331 Corequisites: 57-355

57-381 Accompanying I

Fall and Spring: 3-9 units

This class is the first in a series of hands-on courses which allow the student to accumulate experience accompanying in a professional venue. Students will be assigned to a vocal and/or instrumental studio and will have the opportunity to coach repertoire with a professional accompanist. Assignments may include playing for instrumental juries.

57-382 Accompanying II

Fall and Spring: 3-9 units

Continues 57-381 Accompanying I.

Prerequisites: 57381

57-383 Accompanying III

Fall and Spring: 3-9 units

Continues 57-382 Accompanying II.

Prerequisites: 57382

57-384 Accompanying IV

Fall and Spring: 3-9 units

Continues 57-383 Accompanying III.

Prerequisites: 57383

57-385 Accompanying V

Fall and Spring: 3-9 units

Continues 57-384 Accompanying IV.

Prerequisites: 57384

57-386 Accompanying VI

Fall and Spring: 3-9 units

Continues 57-385 Accompanying V.

Prerequisites: 57385

57-391 Keyboard Studies

Fall and Spring: 3 units

This course develops piano skills necessary for work in the elementary and secondary schools. Special emphasis is placed on transposition, score reading, harmonization and sight-reading. This course is required for all music education majors.

Prerequisites: 57292

57-392 Keyboard Studies

Fall and Spring: 3 units

Continues 57-391 Keyboard Studies V. This course is required for all music education majors.

Prerequisites: 57391

57-393 Keyboard Studies Test (Music Ed)

Fall and Spring: Mini Session - 0 units

This is the keyboard proficiency test which is a requirement for all undergraduate music majors who are music education minors.

57-408 Form and Analysis

Spring: 6 units

This course provides a working understanding of all styles and genres of Western classical and contemporary repertoire. Students will explore various aspects of the compositional process, from basic organizational structures to the details of individual musical phrases. They will learn to see and to hear the most important compositional features of a piece of music and will develop a deeper understanding of the music they perform, conduct, and compose.

Prerequisites: 57153 or 57156

57-417 Major Choral Ensemble

Fall and Spring: 6 units

There are two choral ensembles. Concert Choir is a select ensemble of approximately 40 voices of superior vocal/musical talent and

experience in the choral idiom. Performance requirements are more stringent than those of the Repertory Chorus. Repertory Chorus is an ensemble of undetermined size. Emphasis is placed on vocal technique and development, musical skills in the rehearsal with minimum performance requirements. Audition required.

Corequisites: 57-500, 57-501, 57-502, 57-509, 57-521, 57-522

57-418 Major Instrumental Ensemble

Fall and Spring: 6 units

There are two instrumental ensembles: Orchestra and Wind Ensemble. Rotating seating plans, within and between ensembles, will prevail at the discretion of the Director of Orchestral Studies and the Director of the Wind Ensemble. The instrumental faculty will be consulted. All music majors who are required to enroll in an instrumental ensemble must audition for placement and enroll in Major Instrumental Ensemble. Audition required.

Corequisites: 57-501, 57-502, 57-503, 57-505, 57-506, 57-507, 57-508, 57-509, 57-510, 57-511, 57-512, 57-513, 57-514, 57-516, 57-517, 57-519, 57-520, 57-521, 57-522

57-420 Jazz Vocal Ensemble

Fall and Spring: 3 units

A highly selective group of mixed voices who perform contemporary jazz and pop vocal arrangements. Open to all CMU students. Audition required.

57-422 Horn Choir

Fall and Spring: 3 units

This course refines skills pertaining to ensemble playing. Students will work in groups of varying size. Material will include major orchestral works, pieces expressly written for horn ensemble, and transcriptions. The course is open to all horn majors; non-majors may be accepted by audition.

57-423 Repertoire Orchestra

Fall and Spring: 3 units

This course thoroughly acquaints participants with the standard works one would expect to encounter as part of a career as an orchestral player. Assigned repertoire will be read each class session. All students are eligible to register for this course by special permission. Students who are not placed in the Carnegie Mellon Philharmonic are given priority for registration.

57-424 Percussion Ensemble

Fall and Spring: 3 units

This ensemble is open to all percussion majors.

57-428 Theatre Orchestra

Intermittent: 3-6 units

Instrumental ensemble which accompanies vocal productions in the School of Music or the School of Drama.

57-429 Beginning Piano for Children

Fall and Spring: 6 units

This course is the first of two courses in a year-long internship in the piano teaching of young children, combining class and private instruction: a study of the basic teaching/learning process as applied to piano teaching, covering comprehensive step-by-step presentation in reading, rhythm, ear training, sight reading, technique, and musicianship. Under supervision, students will teach the weekly group class and private lessons. Weekly conferences will be held for learning the presentation of materials for class teaching, analyzing pedagogical problems, and developing communication skills with both young pupils and their parents.

Prerequisites: 57273

57-431 Italian Literature and Repertoire

Spring: 3 units

The course provides a bibliography of repertoire in the Italian language. Material will include art songs and cantatas and will be presented via individual student performances in class, listening to recordings and group survey of repertoire. Reading and writing assignments will serve to establish historical perspective as well as programming considerations.

57-432 French Literature and Repertoire

Spring: 3 units

This course examines French songs for solo voice. Representative works from 18th through 20th centuries will be studied in the context of music history, style and programmatic considerations. Classes consist of individual performance, listening to recordings, and group survey of repertoire. Reading and written assignments establish historical perspective as well as programming considerations.

57-433 Musical Theatre Literature and Repertoire

Fall: 3 units

This class covers music theatre repertoire for two semesters, beginning chronologically with the operetta and concluding with current theatre composers. Each student will be assigned songs to prepare from these musicals. These songs can also be used for music theatre auditions. Students are expected to research all assigned songs and perform them in the proper style. Notebooks must be kept which include all lecture notes, class song assignments and music for songs performed individually.

57-434 Musical Theatre Literature and Repertoire

Spring: 3 units

Continues 57-433 Musical Theatre Literature and Repertoire.
Prerequisites: 57433

57-435 German Literature and Repertoire

Spring: 3 units

The course examines German repertoire composed for solo voice. Representative works from the Baroque period through the 20th Century are studied in the context of musical style, vocal demands and programmatic considerations. Repertoire focuses on art songs and cantatas, but also includes certain oratorio excerpts, which are included frequently in recital programs. A bibliography of German repertoire is compiled through individual or group performance of songs, listening to recordings and through research assignments, the latter of which focuses upon the works of specific composers. Reading assignments are included to establish an historical perspective.

57-436 English/Contemporary Literature and Repertoire

Spring: 3 units

The course provides a bibliography of repertoire in the English language. Material will be limited to art songs and will be presented via individual student or group performances in class, and recorded performances. Research assignments will be required for selected anthologies or for works by specific composers. Repertoire will be examined according to vocal requirements, musical style, and programmatic function. The repertoire will consist primarily of works by British and American composers, but works by Russian and Spanish composers will also be included.

57-437 Literature and Repertoire

Fall and Spring: 3 units

This course deals with literature and repertoire for orchestral instruments. There are multiple sections organized by instrument categories or specific instruments.

57-438 Multitrack Recording

Fall and Spring: Mini Session - 9 units

This course builds upon the ideas learned in Sound Recording (57-337), but with an emphasis on close microphone techniques and popular music styles. Students will work in small groups and complete at least two recording projects. \$10.00 materials fee.
Prerequisites: 57337

57-442 Analytical Techniques

Fall: 6 units

Analytical Techniques is an upper level music support course for juniors and seniors who have completed the undergraduate required music theory curriculum in harmony and counterpoint. Studying the principles of Piston, Forte, Schenker and other important music theorists, students will learn to use whatever analytical techniques are best suited to better understand each individual piece. The primary goal of the course is to develop independent skills in analyzing their own repertoire as performers, conductors, composers, and teachers.
Prerequisites: 57408

57-449 Beginning Piano for Children

Fall and Spring: 6 units

This course is the second of two courses in a year-long internship in the piano teaching of young children, combining class and private instruction: a study of the basic teaching/learning process as applied to piano teaching, covering comprehensive step-by-step presentation in reading, rhythm, ear training, sight reading, technique, and musicianship. Under supervision, students will teach the weekly group class and private lessons. Weekly conferences will be held for learning the presentation of materials for class teaching, analyzing pedagogical problems, and developing communication skills with both young pupils and their parents.
Prerequisites: 57429

57-450 Jazz Ear Training

Fall: 3 units

This course trains the musician's ear in order to listen to and practice the language of jazz. Typical rhythms and phrases are syllabised to train the ear to recognize and reproduce basic articulations needed in playing coherent improvisations. Nomenclature found in the many volumes of fakebooks is examined. Interpretation of the components of "lead sheets" enables the musician to learn repertoire fast and thoroughly. "Personalizing" stock melodies helps the musician give an individual performance of standard tunes and begin to improvise using melodic and harmonic variations. Voicing chord symbols found in standard progressions and examining typical harmonic devices enables the musician to recognize these elements aurally and visually. Intervals through the 13th, construction and function of 3, 4, and 5-note chords, common scales and chord sequences, rhythms and song forms will, through dictation exercises, be made a part of the improviser's language, preparing for the application of these elements in Jazz Improvisation, Jazz Chamber Music, and applied courses offered in the jazz minor curriculum. Listening analysis of the "textbooks" of jazz i.e. recordings, leads to transcription, the life blood of the jazz musician. Listening is an important component of jazz ear training.

57-451 Jazz Arranging

Intermittent: 6 units

This course provides the opportunity for qualified participants to learn to write and arrange for various configurations of standard jazz instrumentation. Elements, including scoring 3, 4, and 5-note chords, intros and codas, melody settings, solo backgrounds, and techniques of rhythm section writing will be applied to examples of the standard jazz repertoire. The final project will be writing an arrangement to be performed by one of the jazz ensembles in the School of Music. A strong background in theory and/or jazz performance and repertoire is recommended. This course is part of the following sequence, which should be taken in this order: Harmony I, Jazz Transcription, Jazz Arranging, Jazz Composition.
Prerequisites: 57454

57-452 Jazz Composition

Intermittent: 6 units

This course will analyze standard jazz forms such as blues, ternary (A-B-A), and binary (ABAC), with written assignments using riff to through-composed techniques. Use of odd meters, extended harmony, modal harmony, and slash chords will be examined. Students will write examples using these forms and techniques. Techniques in writing for rhythm section will be shown, in preparation for jazz arranging. Contemporary jazz composers and their techniques will be analyzed and used in assignments leading to a final project to be performed with a jazz combo. This course is part of the following sequence, which should be taken in this order: Harmony I, Jazz Transcription, Jazz Arranging, Jazz Composition.
Prerequisites: 57451

57-453 Jazz Improvisation

Spring: 3 units

This course applies the concepts and procedures covered in Jazz Ear Training to specific examples in jazz repertoire. Performance of tunes and development of improvisational techniques in a group setting will lead to entering the jam session environment. Free improvisation and improvising "in the style" of other musical genres i.e., blues, rock, funk and classical are explored thus opening the musician to creative solutions in alternative settings. The discipline necessary for this field of study is emphasized. Further development of listening skills and application of those skills to group improvisation will prepare the musician to face the challenges of creating music without the aid of a score. Proficiency on a musical instrument is expected.
Prerequisites: 57450

57-454 Jazz Transcription and Analysis

Intermittent: 6 units

There are few activities an aspiring jazz musician can engage in that are as beneficial as transcribing the improvisational works and compositions of the jazz masters. Every aspect of the student's musical ability is challenged and enhanced. Aural ability, rhythmic notation skills, harmonic theory and function, technique, phrasing, and musicianship are all vastly improved when the student embarks on the painstaking but rewarding process of transcription. The course establishes a framework of basic techniques that help break down this process into manageable goals while moving through the distinct eras of the jazz continuum. This course is part of the following sequence, which should be taken in this order: Harmony I, Jazz Transcription, Jazz Arranging, Jazz Composition.
Prerequisites: 57152

57-457 Jazz History I

Fall: 6 units

This course is part one of a two-semester course in the history of Jazz, considered American "classical music". Part one covers the development of the antecedents of jazz from the time of the slave trade in the Americas through the modern era of the mid 1940s. Evolution of improvisational styles and song writing are examined in class. Exams consist of identifying listening examples and historic performers and eras of the music. Listening and written materials are accessed online through Blackboard with Real Player software. Occasional lecture demonstrations by experts in jazz performance give students the opportunity to hear and see living examples of the essence of jazz. Attending a live jazz performance and writing a 1-2 page review is required.

57-458 Jazz History II

Spring: 6 units

This course is part two of a two-semester course in the history of Jazz, considered American "classical music". (see 57457) The continued evolution of the music and its important contributors is examined in listening examples. The effect of political and social developments in America on the music and jazz musicians' attitudes is reflected in the development of "free jazz" of the sixties. The effect of popular music on jazz in the sixties and seventies as well as trends in the eighties and nineties reflect advances in technology of the music industry. The development of hybrid styles of jazz based upon indigenous cultures of the world brings the music into the 21st century. Attending a live jazz performance and writing a 1-2 page review is required. Jazz History I is not a pre-requisite.

57-459 Score Reading/Keyboard Harmony

Spring: 6 units

This course is for pianists, organists, and other musicians with good keyboard skills. It is a completely practical, hands-on learning experience. Students learn by doing and observing other students. All work is done at the keyboard.
Prerequisites: 57153 or 57156

57-463 Eurhythmics Applications for Non-Majors

Fall and Spring: 6 units

Rhythm is about time and timing. Dalcroze Eurhythmics is an exploration of the rhythm inside us. Experiencing rhythm through music and movement brings awareness and understanding of our own inner rhythm as well as rhythm in all the arts and beyond.

57-465 Eurhythmics Applications for Performing and Teaching

Fall: 6 units

Rhythm is about time and timing. Dalcroze Eurhythmics is an exploration of the rhythm inside us. Experiencing rhythm through music and movement brings awareness and understanding of our own inner rhythm as well as rhythm in all the arts and beyond. For musicians, meaningful rhythmic movement reinforces understanding of music concepts while focusing awareness on the physical demands of artistic performance. This approach to musical problem solving is applicable also to studio and classroom teaching.
Prerequisites: 57164

57-466 Eurhythmics Applications for Performing and Teaching

Spring: 6 units

Rhythm is about time and timing. Dalcroze Eurhythmics is an exploration of the rhythm inside us. Experiencing rhythm through music and movement brings awareness and understanding of our own inner rhythm as well as rhythm in all the arts and beyond. For musicians, meaningful rhythmic movement reinforces understanding of music concepts while focusing awareness on the physical demands of artistic performance. This approach to musical problem solving is applicable also to studio and classroom teaching.
Prerequisites: 57164

57-469 Production: Workshop

Fall: Mini Session - 3-6 units

Preparation of operatic and musical theatre scenes with a public performance of the scenes at the end of the semester. Specific repertoire based upon the proficiency of the individual student.

57-470 Production: Scenes

Spring: 3-6 units

Preparation of operatic and musical theatre scenes with a public performance of the scenes at the end of the semester. Specific repertoire based upon the proficiency of the individual student.

57-471 Production: Performance

Fall: Mini Session - 6 units

Preparation of an operatic or musical theatre production with a fully staged public performance of the production at the end of the class.

57-472 Production: Performance

Spring: Mini Session - 6 units

Preparation of an operatic or musical theatre production with a fully staged public performance of the production at the end of the class.

57-475 The Symphonies of Mahler

Intermittent: Mini Session - 6 units

The eleven symphonic works of Mahler will be analyzed in relation to their form, melodic and harmonic content, counterpoint, orchestration, program, and emotional content. Further topics of discussion will be Mahler's use of beauty sentimentality, banality, tragedy, irony, and humor to present the "Whole Truth" in his symphonic writing. The class will be very interactive with each student expected to make an oral presentation and write a research paper on a symphony of their choice. This seminar style class is open to all upper level undergraduate music students.
Prerequisites: 57284

57-477 Music of the Spirit

Intermittent: 6 units

This is a guided listening course which surveys musical explorations of spirituality. While the majority of repertoire will be from the Western Classical tradition, musics of a variety of cultures will be included. The music will be organized by particular religious traditions and by universal themes, such as community, death/afterlife, birth/new birth, martyrs/heroes, transcendence/immanence, meditation/contemplation/trance, etc. Most course materials, including streaming audio, are online, with one meeting per week in the classroom. Will include participatory introductions to numerous forms of chant. Requires oral and written reports.

57-478 Survey of Historical Recordings

Intermittent: 6 units

This is an elective in CMU's Repertoire+Listening curriculum. Through an intensive listening regimen, illustrated virtual lectures, discussion, and projects, this online course introduces major performing artists and highlights major developments in music media. The emphasis is on classical recordings. But there will also be excursions into influential and iconic popular artists.

57-487 Advanced Solfege III

Fall: 3 units

Covers the same concepts as Solfege IV in more challenging material, from Bach chorales in open score to excerpts by Bartok, Honegger, Stockhausen, or Boulez. Dictations are three-part contrapuntal and difficult harmonic three and four parts.
Prerequisites: 57186

57-488 Advanced Solfege IV

Spring: 3 units

Continues 57-487 Advanced Solfege III.
Prerequisites: 57487

57-491 Solfege Seminar

Intermittent: 3 units

This course is for undergraduate students who have completed the four-semester sequence of required solfege courses and for graduate students. Solfege concepts are explored in more depth in a laboratory setting in class. This is a mini-course which meets during the first half of the semester.
Prerequisites: 57184 or 57488

57-492 Advanced Solfege Seminar

Intermittent: 3 units

This course is for undergraduate students who have completed Advanced Solfege IV and for graduate students with similar preparation. It will help the student cope with the melodic, harmonic, and rhythmic problems, presented in dictation, encountered in twentieth century music. This is a mini-course which meets during the second half of the semester.
Prerequisites: 57488 or 57491

57-500 Major Studio (Voice)

Fall and Spring: 9 units

A one hour private lesson per week for all music majors.
Prerequisites:

57-501 Major Studio (Piano)

Fall and Spring: 9 units

A one hour private lesson per week for all music majors.
Prerequisites:

57-502 Major Studio (Organ)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-503 Major Studio (Harp)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-505 Major Studio (Violin)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-506 Major Studio (Viola)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-507 Major Studio (Cello)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-508 Major Studio (Double Bass)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-509 Major Studio (Guitar)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-510 Major Studio (Flute)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-511 Major Studio (Oboe)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-512 Major Studio (Clarinet)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-513 Major Studio (Bassoon)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-514 Major Studio (Saxophone)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-515 Major Studio (Horn)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-516 Major Studio (Trumpet)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-517 Major Studio (Trombone)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-518 Major Studio (Euphonium/Baritone)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-519 Major Studio (Tuba)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-520 Major Studio (Percussion)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-521 Major Studio (Composition)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-522 Major Studio (Bagpipe)

Fall and Spring: 9 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-597 Senior Project

Fall and Spring: Mini Session - 0 units
A composition for orchestra required of all senior composition majors.

57-598 Junior Recital

Fall and Spring: Mini Session - 0 units
A half recital required of all junior performance majors.

57-599 Senior Recital

Fall and Spring: Mini Session - 0 units
A full recital required of all senior performance majors.

57-603 Practice Teaching (Elementary)

Fall and Spring: 6-18 units
Experience in working with elementary students in a public school setting. The teaching is supervised by an experienced public school teacher and members of the CMU music education faculty.
Prerequisites: 57355 and 57393

57-604 Practice Teaching (Secondary)

Fall and Spring: 6-18 units
Experience in working with secondary students in a public school setting. The teaching is supervised by an experienced public school teacher and members of the CMU music education faculty. Students may choose a vocal or instrumental emphasis in the secondary placement.
Prerequisites: 57355 and 57393

57-607 Vocal Methods

Spring: 3 units
This course enables each student to develop a pleasant, healthy, and musically expressive voice and to develop effective vocal pedagogy.

57-608 Observation

Fall: 3 units
This music education offering is an independent study course designed to introduce students to a range of instructional practices used by elementary and secondary strategies that impact learning, student motivation, classroom management, and accommodations for special learners.
Prerequisites: Corequisites: 57-331

57-610 Internship

Fall and Spring: 3-36 units
A student can receive credit for an unpaid internship in a music related field. The amount of credit is determined by the number of internship hours.

57-611 Independent Study in History

Fall and Spring: 3-9 units
Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-612 Independent Study in Theory

Fall and Spring: 3-9 units
Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-613 Independent Study in Research

Fall and Spring: 3-9 units
Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty

member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-614 Independent Study in Performance

Fall and Spring: 3-9 units

Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-615 Independent Study in Electronic and Computer Music

Fall and Spring: 3-9 units

Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-616 Independent Study in Literature and Repertoire

Fall and Spring: 3-9 units

Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-617 Independent Study in Sound Recording

Fall and Spring: 3-9 units

Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-618 Independent Study in Conducting

Fall and Spring: 3-9 units

Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-619 Independent Study in Opera

Fall and Spring: 3-9 units

Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-620 Independent Study in Solfege

Fall and Spring: 3-9 units

Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-621 Independent Study in Eurhythmics

Fall and Spring: 3-9 units

Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-622 Independent Study for Competitions

Fall and Spring: 3 units

Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-623 Independent Study in Diction

Fall and Spring: 3-9 units

Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-624 Independent Study in Theater Composition

Fall and Spring: 3-9 units

Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the project will be completed. Open to upperclassmen.

57-641 Dalcroze Research Paper

Fall and Spring: 3 units

Candidates in the Dalcroze Certification Program are required to submit a research paper based on their understanding of Dalcroze principles based on their experience and supported by appropriate literature.

57-661 Piano Maintenance I

Fall: 6 units

An introduction to the field of piano technology. A focused study and application of the tools, techniques and theories of piano maintenance. Private lessons, class time and group projects are used equally to develop the core knowledge of this field. Prospective students should possess good hearing.

57-691 Dalcroze Pedagogy/Practice Teaching

Fall: 3-6 units

This first semester of a two semester course focuses on Dalcroze pedagogy and supervised practice teaching with pre-school and elementary school age children.

Prerequisites:

57-692 Dalcroze Pedagogy/Practice Teaching

Spring: 3-6 units

This second semester of a two semester course focuses on applications of Dalcroze pedagogy and practice teaching with upper elementary and middle school age students.

Prerequisites:

Art

60-101 Concept Studio I

10 units

"The Self and the Human Being" The first of a sequence of eight studio courses designed to develop a personal approach to generating art and to learning transferable conceptual skills. The topics of the first three Concept Studios are addressed through a sequence of structured, media-independent projects. Open to freshmen admitted to the School of Art, or by instructor permission.

60-102 Concept Studio II

Spring: 10 units

"Space and Time" A continuation of Concept Studio I with a focus on space and time through projects of increasing complexity. Such topics as biological time, historical time, psychological time, celestial time, clock time, and public space, private space, mathematical space, and virtual space are addressed through projects. Open to freshmen in the School of Art, or by instructor permission.

60-104 Contemporary Issues Forum

Fall: 6 units

This introductory class presents to students a diverse range of contemporary issues in the visual arts. It is organized in a thematic way rather than chronologically. There will be readings, discussions, and papers. Lecture/discussion format. All students are required to attend the School of Art bi-weekly lecture series. Open to freshmen in the School of Art, or by instructor permission.

60-110 Electronic Media Studio I

Fall: 10 units

An introduction to the computer as a multi-purpose, art-making tool that utilizes software application programs. Students use the computer to develop a variety of two-dimensional imagery, animated and interactive artworks. Multiple output media and distribution options are explored. Open to freshmen admitted to the School of Art, or by instructor permission.

60-130 3-D Media Studio I

Spring: 10 units

An introduction to three-dimensional form and space. Various materials and methods are explored through projects covering a broad range of sculptural concerns. Students are introduced to welding techniques, wood fabrication and ceramic processes. Students become proficient with a variety of hand and power tools. Materials fee required. Open to freshmen in the School of Art, or by instructor permission.

60-141 Black and White Photography I
9 units

This course will teach you the basic craft of photography from exposure of the negative through darkroom developing and printing to print finishing and presentation. Content includes student presentations, class discussions, shooting assignments, darkroom sessions and class critiques. We will concentrate not only on the technical aspects of photography, but also the aesthetics of seeing with a camera. The course concentrates on photography as a fine art -- what is unique to it and the concerns that are shared with other visual arts, such as composition, tonal values, etc. and aims to equip students with an understanding of the formal issues and the expressive potentials of the medium. Lab fee and 35mm manual camera required. Each student is responsible for the cost of paper and film. No prerequisites.

60-150 2D Media Studio I: Drawing
Fall: 10 units

The first of a two-semester sequence of drawing courses. Focus on the language, materials and concepts of drawing as foundation for all the visual arts. Initial emphasis on the development of perceptual, analytical, and structural drawing skills with increasing attention to idea development. Exposure to methods of creating pictorial and illusionistic space; recording the external world of light and form; and making visible the internal world of the heart, the mind, the soul. Experience with line, texture, tone, shape and mass; in a variety of wet and dry drawing media. Open to freshmen in the School of Art, or by instructor permission.

60-151 2D Media Studio II: Drawing
Spring: 10 units

A continuation of 60-150 2D Media Studio I: Drawing. Includes an expanded exploration of 2D materials, techniques, and processes. Emphasis on drawing as a foundation for various forms of artmaking. Open to freshmen in the School of Art, or by instructor permission.

60-201 Concept Studio III
Fall: 10 units

"Systems and Processes" A continuation of Concept Studios I and II with a focus on systems and processes. The utility, discovery, and the generation of systems and processes are addressed through projects. Open to sophomores in the School of Art, or by permission of instructor.

60-203 Sophomore Honors Project
Spring: 10 units

A non-medium-specific studio course which encourages students to develop independently generated projects. Open to sophomores in the School of Art with a minimum QPA of 3.0.

60-205 Modern Visual Culture 1789-1945
Fall: 9 units

Explores the diverse roles of artists in the complexity of modern society from the Industrial Revolution through World War II. Contextual issues include the relationship of artists and art to culture, politics, economics and modern technologies. Attention is paid to the decline of patronage, the diminishing role of the academy and the emergence of an avant-garde and art promotion. Open to sophomores in the School of Art, or by instructor permission.

60-206 Contemporary Visual Culture from 1945 to the Present
Spring: 9 units

This course traces the shifts in art from late Modernism until our After Post era. It will examine the diversity of art produced, as well as the critical ideas that arose over a span of 60 years. The rise of a pluralist / conceptual art will be discussed within the context of social change, technology and globalization. Open to sophomores in the School of Art, or ONLY by the instructor permission.

60-210 Electronic Media Studio II
Fall and Spring: 10 units

Introduction to video production. Explore video art production, post and pre-production. Focus on skills needed to realize intended video projects through discussions and examples of processes, techniques and aesthetic issues. We will look at multi-media, computer effects and digital audio. We will move from traditional narrative to experimental and performative/installation work.

60-230 3-D Media Studio II
Fall: 10 units

An introduction to light metalworking techniques, foundry processes and mixed media construction. A broad range of techniques and processes are introduced through demonstrations and placed into practice through assignments. Students gain a basic understanding

of the language and processes of sculpture. Materials fee required. Open to School of Art sophomores, or by instructor permission. Prerequisites: 60130

60-250 2D Media Studio III: Painting
Fall and Spring: 10 units

A pragmatic introduction to the tools, materials, and techniques of painting, including instruction in the fabrication of sound painting supports and the application of permanent grounds. Students become conversant with the range of visual options unique to the vocabulary of painting.

60-251 2D Media Studio IV: Print Media
Spring: 10 units

An introduction to the three major areas of printmaking: Intaglio, Lithography, and Serigraphy. Provides students with an overview of printmaking in its historical context. Demonstrates the impact of the print processes on contemporary art. Open to sophomores in the School of Art, or by instructor permission.

60-301 Contextual Practice
Fall: 10 units

This course has an outreach focus, which allows students to create art outside traditional artistic venues. In developing their individual projects, students will explore what it means to be an artist outside the art school studio: how to make connections with a new audience; how to translate artistic vision into statements that are comprehensible and meaningful to a non-artist community; and how to apply personal aesthetics and interests to non-traditional settings. The types of projects chosen are limited only by the students' imaginations: events, performances, temporary installations, graphics, sculptures, sound works, projected images, and interactive productions are only some of the varieties of projects that may be developed. Projects may be specific to a selected site, or they may address particular characteristics of a location, such as its history or physical setting, or its role in the community. Students may seek support from local organizations or institutions, or create works in collaboration with a selected community.

60-303 Junior Honors Project
Spring: 10 units

A non-medium-specific studio course which encourages students to develop independently generated projects. Open to juniors in the School of Art with a minimum QPA of 3.0.

60-353 High and Popular Culture in the Arts
Intermittent: 9 units

Explores issues influencing art at the close of this century. Investigates the impact on culture and creative thinking by social, political and technological developments since World War II. Analyzes how the visual slang of mass culture has entered the language of modern art. Priority for art majors.

60-354 Art Aesthetics and Literature
Intermittent: 9 units

Surveys the development of modernist European aesthetics, as expressed in the applied forms of art and literature. Focuses on the parallels between visual and literary movements, and on the deviation of these movements from their philosophical counterparts. Discusses aesthetic systems, those arising out of German idealism, Existentialism, Psychoanalysis, and Phenomenology.

60-399 Art History/Theory Independent Study
All Semesters: 9 units

A tutorial course in which an Art student works individually on a self-generated project under the supervision of a School of Art faculty member. Prior to enrolling in Independent Study, the student must complete an "Independent Study Proposal" form (available in the bins on the 3rd floor of CFA) which is signed by the faculty member and the Assistant Head of the School of Art. Prerequisite: Art junior or senior status, or by instructor permission.

60-401 Senior Project
Fall: 10 units

Students initiate a comprehensive two-semester project in the first semester to be completed in the second semester of their senior year (60-402). Open to seniors in the School of Art, or by instructor permission.

60-414 Advanced ETB: Animation Art and Technology
Spring: 12 units

Animation Art and Technology is an interdisciplinary course cross-listed between Art and Computer Science. Faculty and teaching assistants from computer science and art teach the class as a team. It is a project-based course in which four to five interdisciplinary

teams of students produce animations. Most of the animations have a substantive technical component and the students are challenged to consider innovation with content to be equal with the technical. The class includes basic tutorials for work in Maya leading toward more advanced applications and extensions of the software such as motion capture and algorithms for animating cloth, hair, particles, and grouping behaviors. The first class will meet in CFA room 303.

60-415 Advanced ETB: Animation

Fall: 10 units

This studio will introduce students to a variety of 3-D computer and 2-D drawn animation techniques. The class will look at and discuss examples of historic and contemporary animation. The students will explore animation through a variety of short experiments and develop individual projects that use animation as a means of self expression.

60-416 Advanced ETB: Interactive Multimedia

Intermittent: 10 units

Within this class students will engage in a personally directed exploration of the creative, conceptual and tactical possibilities of interactive scenarios within their art practice. The term "interactivity" will be used and discussed in its broadest possible context, and students will be given space to explore a wide range of digital and non-digital approaches to user orientated strategies within the art making process. We will also examine and discuss a range of historical and contemporary strategies employed by art makers who have used forums from on-line and virtual spaces to physical and site specific venues to expand and explore the relationship between the art object and the audience.

Prerequisites: 60110 and 60210

60-417 Advanced ETB: Video

Intermittent: 10 units

ADVANCED VIDEO -- This course offers an in depth exploration of video as a tool for creative expression. Topics for investigation and discussion will include: histories of experimental video, contemporary trends in the field, technological developments, performativity, perception and manipulation of time, and theories of representation. Additionally this course will provide instruction in advanced production and post-production techniques, including lighting, editing, compositing, 2D animation, graphics and sound design.

60-421 Advanced ETB: Gizmology

Intermittent: 10 units

Gizmology introduces artists to the fascinating, real world of three-dimensional time-based/kinetic media. Students will be given intensive instruction in digital electronics as well as an introduction to mechanics and machine/sculpture fabrication. Students will complete assignments as well as pursue their own self-directed kinetic project. A \$60.00 material fee is required.

Prerequisites: 60110 and 60210

60-422 Advanced ETB: Robotic Art Studio

Intermittent: 10 units

Advanced ETB: Robotic Art Studio (Fabian Winkler). The Robotic Art Studio is an experimental and interdisciplinary class. It focuses on three areas: technical workshops exploring basic electronics, the presentation and discussion of key texts relevant to robotic art and the creation of individual art works. In the technical workshops students will explore the functionality of basic electronic components, work with sensors, actuators and alternative power sources such as solar energy. In the discussion of assigned readings, we investigate some of the cultural, social and technological issues inherent to the field of robotics. These discussions will be complemented and extended by presentations of relevant historic and contemporary artworks. Students will also work on a variety of different project assignments, some of them exploring the networking of individual work to a system. A course material fee is required. Students can expect to purchase some individual items outside of those provided if they are unique to their project design.

60-425 Advanced ETB: Live Video

Intermittent: 10 units

Advanced ETB: Live Video - Using analog and digital tools, software and hardware, students will create independent and collaborative live video performances and events. Additionally we will engage in study and discussion around issues of liveness, mediation, representation and embodied experience.

60-429 Advanced ETB: Special Topic

Intermittent: 10 units

Advanced ETB: Tactical Media - This course considers the practice and theory of tactical media, hacktivism, and other media-

based strategies of cultural disruption, protest and critique. The course examines the history of artists, activists, pranksters and interventionists who use emerging communications media in novel and unconventional ways, as exemplified by such groups as The Yes Men, Critical Art Ensemble, Preemptive Media, Franko and Eva Mattes and others. Students will develop several projects that employ skills in digital and physical media to create works that creatively engage with audiences in contexts that may not be traditionally associated with art.

60-430 Advanced SIS: Sculpture

Intermittent: 10 units

Sculpture is perhaps the broadest field among the contemporary visual arts. Through its privileged relationship to the physical world and the viewer's body, sculpture is the glue that connects the intermedia practices of object, installation, interactive art and performance. In this class we build on skills and concepts learned in 3D media 1 and 2 to develop students' individual approach. Students define independent responses to topics proposed through discussion of contemporary sculptors. Emphasis is placed on individual development. Students are encouraged to explore interdisciplinary approaches.

60-431 Advanced SIS: Installation

Intermittent: 10 units

At the heart of installation art is the desire to immersively engage the viewer in unanticipated spaces and environments in which visual and intellectual habits are challenged or disrupted. Installation is not defined by medium, or site, but by a continual struggle to expand the relationship between the artist and the audience. In addition to creating works for "neutral" spaces, like galleries and museums, students will also be producing work within the preexistent social, architectural, and sensory fabric of their daily lives. As installation art is an ever-expanding territory, we will start with the term "space," and what constitutes its myriad definitions, as a nexus for inquiry and production. This class encourages enrollment from students in any discipline, inside or outside of the School of Art.

60-432 Advanced SIS: Site-Work

Intermittent: 10 units

Studio focus on work designed for a specific site. Object work, installations, and environmental work are included. Site analysis, environmental work, and social dimensions are addressed.

60-433 Advanced SIS: Clay

Intermittent: 10 units

Studio focus on ceramic materials and processes as applied to sculptural issues. Fabrication, glazing, and kiln-firing are addressed. Material fee required.

Prerequisites: 60130

60-434 Advanced SIS: Foundry

Intermittent: 10 units

Studio focus on metal casting processes. Objects are created in clay, wax, wood and plaster and cast into bronze or aluminum. Fabrication and welding techniques are presented. Materials fee required.

60-435 SIS: Metals

Intermittent: 10 units

Studio focus on fabrication using light metalworking techniques including forming, joining, and finishing. Metalsmithing and jewelry techniques will be explored in the context of sculptural issues. Metal stretching, forging, brazing, texturing, small scale casting and coloring are also presented. Slides looking at small scale metalwork, as well contemporary sculpture using metal techniques will be presented periodically. Metals provided include copper, brass, and bronze sheet and wire. Materials fee will also cover silver solder and other expendables.

60-437 Advanced SIS: Environmental Sculpture

Intermittent: 10 units

Studio focus on sculpting with the environment. Design and build natural growing systems to enhance the built environment and/or open space, empty urban lots, etc. Includes object making, installations and site work with an emphasis on ecological materials, environmental impact and related issues. Students required to explore and develop proposal-making skills in order to implement a site-specific project on or off campus.

60-438 Advanced SIS: Intimate Objects

Intermittent: 10 units

60-438 Advanced SIS: Intimate Objects (Carol Kumata). Explores the issues of small scale sculpture. This class will deal with the creation of objects that require a one-on-one interaction with the

viewer. Unlike much heroically scaled sculpture, there is a distinctly personal and intimate connection that these objects engender. The class will look at historical examples, as well as 20th century works starting with the dada and surrealists. Problems of small scale sculpture will include topics such as the miniature versus actual size, the nature of materials, the issues of craftsmanship, the problem of preciousness. Sophomore status. Priority to Art majors.

60-450 Advanced PDP: Drawing
Intermittent: 10 units

Studio course with an expanded definition of drawing to include a large variety of media, methodologies and practices. Subjects will include observable sources as well as conceptual approaches. Students will be encouraged to identify resources, research and develop a sustained body of work.

60-451 Advanced PDP: Anatomy/Drawing
Intermittent: 10 units

60-451 Advanced PDP: Anatomy/Drawing. For thousands of years artists have seen the human body as an object of beauty, and as a powerful metaphor for documenting the passion and the pathos of human experience. This course will focus on that complex and compelling subject. In class, students will work from the model, studying the figure as a means to heighten sensitivity, expand visual perception, and refine drawing skills. An introduction to the landmarks of anatomical bone and muscle structure will be included. Outside class, students will be encouraged to seek meaning in the humanity of the figure as a vessel for expression, be it personal, social, political, spiritual, narrative or emotional.

60-453 Advanced PDP: Painting
Fall and Spring: 10 units

In this course you will be encouraged to expand your skills and develop a personal vision, while maintaining a spirit of investigation into the developmental process, the magic, the illusion and the physical reality of painting. The professor will act as critic and advisor as students work independently developing self-generated ideas and setting personal goals. We will meet as a class for group critiques, discussions, presentations on the practical aspects of the profession, and slide lectures on contemporary artists.

60-455 Advanced PDP: Intaglio
Intermittent: 10 units

60-455 Advanced PDP: Intaglio. Advanced intaglio studio focuses on the development of additional techniques such as lift and soft grounds, photographic processes, color and multiple plate printing, and viscosity printing. Emphasis will be placed on artistic/image development in relationship to the print as a democratic multiple. In addition cross disciplinary work will be encouraged within other printmaking studios to expand the visual vocabulary and image development.

Prerequisites: 60251

60-456 Advanced PDP: Lithography
Intermittent: 10 units

Studio focus on the processes and issues of lithographic printmaking. Includes both traditional stone and aluminum plate processes along with photographic techniques.

60-457 Advanced PDP: Idea Generation
Intermittent: 10 units

This course will support rapid development within each student's self-directed body of work. The course will facilitate the development of that body of work by challenging it through a series of exercises designed to alter habits, question assumptions, provoke material and procedural experimentation, multiply avenues of approach, and expand on the conceptual issues inherent in the work. Materials and content will be determined by each student individually (primarily 2-D media but trans-media and crossover experiments will be encouraged). Sophomore status. Priority to Art students.

60-458 Advanced PDP: Serigraphy
Intermittent: 10 units

Advanced PDP: Serigraphy. Studio focus on processes and artmaking issues related to water-based/acrylic serigraphy. Emphasis on individual conceptual/artistic development. Material fee required.

60-465 Advanced PDP: bioGRAPHICAL
Intermittent: 10 units

Emphasis in this class will be on creating visual narratives that combine writing and sequential drawing. Students will demonstrate increasing skill in storytelling, visualization, and a familiarity with the tools and techniques common to the creation of comix. Students will create self-generated projects, featuring stories as told by other

people, and as generated out of a wide range of interactions with people unlike themselves. This course may be counted towards the Art in Context requirement for majors in the School of Art.

60-466 Advanced PDP: Materials and Techniques
Intermittent: 10 units

A hands-on study of the manufacture and use of permanent painting media. Students will learn how to make and use a variety of paints, supports and grounds including oil paint, egg tempera, encaustic, gouache, distemper, casein and fresco. The properties of various additives to and combinations of these media will be explored. Technical issues affecting longevity will be addressed, but experimentation will be encouraged. The second half of the semester will consist of self-directed studio work focusing on the ways in which each student's personal vision can be embodied in one or more of the above media.

60-467 Advanced PDP: Printstallation: Hybrid Works and Collaborative Projects
Intermittent: 10 units

In this team-taught course, students will examine the role of print media in and as installation, addressing the print as multiple rather than as discrete object. Collaboration will play a fundamental role in class projects, as students develop work across print media, including intaglio, litho, screen and digital. This advanced course is open to juniors and seniors and will encourage interdisciplinary and collaborative work and experimentation. Students may enroll in either section A or B of this course. Each section will be team-taught by Kim Beck and Ayanah Moor.

Prerequisites: 60251

60-499 Studio Independent Study
All Semesters: 5-10 units

A tutorial studio in which an Art student works individually on a self-generated project under the supervision of a School of Art faculty member. Prior to enrolling in Independent Study, the student must complete an "Independent Study Proposal" form (available in the bins on the 3rd floor of CFA) which is signed by the faculty member and the Assistant Head of the School of Art. Prerequisite: Art Junior/Senior status and by instructor permission.

60-590 Internship
Fall and Spring: 1-9 units

Art Internships are open to all BFA, BHA and BSA Art students. Internships may take place with appropriate individuals or organizations within or outside of Carnegie Mellon University. The requirements for an internship are in the School of Art "Undergraduate Handbook" (available at the School of Art website). Prior to being enrolled for an internship, students must complete an Internship Proposal Form, which defines the goals of the internship. This form must be signed by their site supervisor and approved by the Assistant Head of the School of Art. Forms are available in the bins on the 3rd floor of CFA. Junior and Senior Art majors only.

CFA Interdisciplinary

62-102 Modern Dance Workshop
Fall and Spring: 6 units

A modern dance class based on the philosophy of the Martha Graham technique. The class is designed to encourage exploration and discovery of the roots of physical movement and control. The class also covers fundamental and technical aspects of modern dance as a classical performing arts form.

62-141 Black and White Photography I
Fall and Spring: 9 units

This course will teach you the basic craft of photography from exposure of the negative through darkroom developing and printing to print finishing and presentation. Content includes student presentations, class discussions, shooting assignments, darkroom sessions and class critiques. We will concentrate not only on the technical aspects of photography, but also the aesthetics of seeing with a camera. The course concentrates on photography as a fine art -- what is unique to it and the concerns that are shared with other visual arts, such as composition, tonal values, etc. and aims to equip students with an understanding of the formal issues and the expressive potentials of the medium. Lab fee and 35mm manual camera required. Each student is responsible for the cost of paper and film.

62-190 BHA, BSA & BCSA Freshman Research Seminar
Fall: 9 units

This course is designed to introduce students in the Bachelor of Humanities and Arts (BHA), Bachelor of Science and Arts (BSA),

and Bachelor of Computer Science and Arts (BCSA) Programs to research methodology. Structured according to the fields of interests of the participating students, the course syllabus remains fluid and attentive to the unique make-up of each incoming freshman class. This course examines the two main paradigms that form the basis of research in various fields of inquiry: 1) the systematic, scientific, or positivist approach, and 2) the qualitative, ethnographic, and ecological or naturalistic approach. Instructor: Sciannameo.

62-241 Black and White Photography II

Intermittent: 9 units

A continuation of topics explored in Black and White Photography I with an emphasis on aesthetic development and image evaluation. Students will gain experience with a variety of formats; experimental methods and media will be encouraged. Folio or equivalent required by end of the semester. Course has lab fee. Prerequisites: 62141

62-245 Portrait Photography

Intermittent: 9 units

Portrait Photography explores the emotional and visual process of collaboration between subject and photographer that creates a photograph. We'll use cameras of all formats and levels of sophistication to create portraits in the studio and on location. We'll find and exploit available light and create artificial light to complete our vision, and we'll explore a wide range of darkroom strategies to support and add richness to our final print. Through film and video we'll meet some of the masters of this form like Arbus, Newman, Avedon and Penn, and we'll take advantage of any opportunities to visit exhibitions and photographers studios. Lab fee required. Prerequisites: 62141

62-247 Introduction to Hot Glass I

Fall and Spring: 3 units

Introduction to Hot Glass I - 3 Units For beginners with little or no hot shop experience, this class will emphasize safety, proper tool use, communication, and a team approach to glassblowing, while executing simple blown forms such as cups and bowls in clear glass. No previous glassworking experience required. Basic materials provided. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please go to CFA 100 to sign up. Spaces are limited. Course fee is \$275. Not eligible for PCHE Cross Registration. Course taught at the Pittsburgh Glass Center.

62-265 Alternative Photo Processes

Intermittent: 9 units

This course is an exploration of nineteenth century, non-silver and alternative photographic process techniques. Students will produce large format imagery by use of traditional large format shooting, analogue negative enlarging and/or digital negative methods. Hand-applied printing processes investigated in this course include van dyke, cyanotype, salt/POP, albumen, platinum/palladium, and gum bichromate. Other non-traditional techniques will also be explored including, pinhole photography, liquid light, image manipulation, Lazertran and cliché verre. Each student develops a self-directed project using one or more of these mediums. Prerequisites: 62141

62-325 View Camera

Intermittent: 9 units

The nature of a 4x5" view camera alters both the process of making a photograph and the qualities of the resulting image. The slow, even cumbersome, process of photographing with a large format camera encourages a methodical, studied approach. The larger negative size and the ability to control the exposure and development of each sheet of film make possible an image of extraordinary clarity and detail. Through a series of exercises followed by a self-selected project, students in this class will learn the technical aspects, and master the use of, the view camera. Topics include: perspective and focal plane control, bellows extension factor, and basic B&W sheet film handling and processing. Students should enter this course already possessing a working knowledge of photographic processing and printing. Prerequisites: 62205 or 62241 or 62245 or 62265 or 62326 or 62337 or 62381 or 62141

62-337 Studio Lighting

Intermittent: 9 units

This course provides a working knowledge of studio-based lighting techniques. Students will create photographs using artificial light - both "hot" lights and electronic flash units. Assignments will include table-top/still life and portraiture. Students can use cameras of any format to complete assignments, but class instruction will emphasize the use of 4X5 cameras that are available to all studio

lighting students. To successfully complete assignments students will be required to purchase paper, film, and 4X5 Polaroid film, or create images using digital capture. The class may visit off-campus galleries and museums, and will invite photographers for special presentations. Grading is based on attendance, assignment critiques, and the final portfolio.

Prerequisites: Corequisites: 62-241, 62-141

62-347 Hot Glass II

Fall and Spring: 3 units

Students will refine and vary the cup and bowl shape in the first few weeks. Proficiency and efficiency in working the glass will be emphasized before moving on to more complex shapes. Some basic methods of color application will be explored, and students will learn how to troubleshoot common problems. 24 hours of hot glass class/workshop experience required, or by permission of the instructor. Basic materials provided. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please go to CFA 100 to sign up. Spaces are limited. Course fee is \$275. Not eligible for PCHE cross registration. Course taught at the Pittsburgh Glass Center.

62-358 Art and Biology

Intermittent: 9 units

This studio- laboratory hybrid course explores the fusion of art and biology. It is an opportunity for students interested in interdisciplinary concepts to work both in a fine arts environment and a biological laboratory. In addition to art-science projects, the course includes lectures, discussions and media presentations. Students are introduced both to the work of artists whose art is based in science as well as to the work of scientists who use visual data to inform their scientific work. Students have the opportunity to experiment creatively with scientific media such as electron and video-probe microscopy.

62-381 Color Photography and Digital Output

Intermittent: 9 units

This course will merge the practice of color film/digital photography with digital printing methods. Students will gain an understanding of color theory and aesthetics, while better defining their individual voices. By semester's end, students will have a finely printed body of work using Adobe PhotoShop and high-end digital output devices. Prerequisites: Corequisites: 62-141

62-390 BHA BSA & BCSA Independent Research Project

All Semesters: 3,6,9,12 units

This Independent Research Project is for Bachelor of Humanities and Arts (BHA), Bachelor of Science and Arts (BSA), and Bachelor of Computer Science and Arts (BCSA) students who want to work on a self-designed project with the one-to-one guidance of a faculty advisor. The project should be interdisciplinary in nature, and can be a scholarly and/or creative endeavor. The project may take the form of a written thesis, a compilation of creative works, an outreach project, etc. The project topic must be pre-approved by the faculty member who agrees to supervise the project and assign a letter grade for the course. Projects are to be completed in one semester, and may be worth 3, 6, 9, or 12 units of academic credit. To register, students must submit an "Independent Research Project Proposal Form" signed by both the student and the faculty advisor, along with a proposal, to the Associate Director of the BHA, BSA & BCSA Programs.

62-400 BHA BSA BCSA Senior Project

All Semesters: 9 units

The BHA, BSA & BCSA Senior Project allows Bachelor of Humanities and Arts (BHA), Bachelor of Science and Arts (BSA), and Bachelor of Computer Science and Arts (BCSA) students the opportunity to weave together the interdisciplinary elements of their curricula into an integrated project. The Senior Project should reflect the student's interdisciplinary vision in the arts and humanities or arts and sciences. The creation and completion of such a project can be an important integrative and fulfilling capstone for BHA, BSA and BCSA students. Senior Projects are semester-long or year-long (9 units for one semester; 18 units for two semesters), and are structured as independent studies under the supervision of a single faculty member or a small committee of faculty from the areas relevant to the project. To register, the student must submit a "Senior Project Proposal Form" signed by the student and faculty advisor, along with a proposal, to the Director of BHA, BSA & BCSA Programs for final approval.

62-446 Hot Glass III

Fall and Spring: 3 units

This class will touch upon a broad range of more complicated techniques including use of solid color, mold blowing, and

compound shapes. Students will be encouraged to focus on directions that interest them, and will continue to refine basic skills and methodology. This class can be repeated; content will vary by session. 48 hours of hot glass class/workshop experience required, or by permission of the instructor. Basic materials provided. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please go to CFA 100 to sign up. Spaces are limited. Course fee is \$275. Not eligible for PCHE cross registration. Course taught at the Pittsburgh Glass Center.

62-450 Flame I

Fall and Spring: 3 units

A great combination class to explore the variety in flameworking. Students will work with both Moretti (soft) and borosilicate (hard) glass, to create and manipulate simple forms in the flame such as beads, marbles, and sculptural elements, and will explore techniques including pulling points and blowing. No glass working experience is required. All materials provided. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please go to CFA 100 to sign up. Spaces are limited. Course fee is \$162.50. Not eligible for PCHE cross registration. Course taught at the Pittsburgh Glass Center.

62-451 Flame II - Molding Moretti

Fall and Spring: 3 units

Students will hone their torchworking skills while learning new techniques for sculpting soft glass in the flame. This class will include a deeper exploration of marble making and beadmaking, and expand into more advanced techniques including cane pulling and the sculpting of small figures such as insects. Flameworking I or 24 hours experience required. Basic materials provided. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please go to CFA 100 to sign up. Spaces are limited. Course fee is \$162.50. Not eligible for PCHE cross registration. Course taught at the Pittsburgh Glass Center.

62-452 Flame II- Blowing Boro

Fall and Spring: 3 units

This class will start with a review of pulling points and blowing simple hollow forms and expand into the creation of small vessels including jars and perfume bottles. Techniques covered will include welding and encalmo, and various cane and color applications. Flameworking I or 24 hours experience required. Basic materials provided. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please go to CFA 100 to sign up. There is a \$162.50 Course Fee. Spaces are limited. Not eligible for PCHE Cross-Registration. Course taught at the Pittsburgh Glass Center.

62-453 Fusing and Slumping

Fall and Spring: 3 units

Come and learn the ancient, beautiful and fun art of fused and slumped glass. A blend of art and science, this course will be an overview of glass compatibility and lamination as well as fusing and slumping techniques. Utilizing heat, gravity and time, students will be guided through the process via lectures and demonstrations. No glass working experience required. Basic materials provided. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please go to CFA 100 to sign up. Spaces are limited. Course Fee is \$225. Not eligible for PCHE cross registration. Course taught at the Pittsburgh Glass Center.

62-455 Kiln Casting

Fall and Spring: 3 units

Students will be introduced to the art of kiln casting through the creation of small objects including sculptures and non-functional vessels out of glass using a variety of mold making and kiln casting techniques. This class will cover constructing models, making refractory molds, preparing the glass, firing the molds in kilns and resolving castings into finished works of art. No glass working experience required. All basic materials provided. Registration can only be done on your scheduled registration day and is done on a first come, first serve basis. Please go to CFA 100 to sign up. Spaces are limited. Course Fee is \$250. Not eligible for PCHE cross registration. Course taught at the Pittsburgh Glass Center.

62-590 BHA BSA BCSA Internship

All Semesters: 3,6,9,12 units

An internship is a supervised professional work experience with clear links to a student's academic goals. BHA, BSA and BCSA students may choose to complete an internship for elective credit with appropriate individuals or organizations within or outside of Carnegie Mellon. Sophomore, junior and senior BHA, BSA and BCSA students in good academic standing are eligible to receive academic credit for one internship. Grading is pass/fail only. Prior to enrolling

in an internship, the student must have an "Internship Proposal Form" signed by their site supervisor and approved by the Associate Director of the BHA, BSA & BCSA Programs.

H&SS Interdisciplinary

66-301 Science and Christianity: A Multidisciplinary Approach

Intermittent: 9 units

Christianity and Science is a multidisciplinary lecture/discussion course that is part of the interdepartmental program in religious studies at Carnegie Mellon University. The nature and history of Christianity are considered in light of the cultural, political, philosophical and theological background of the patristic period (0-600 CE). The nature and history of science is developed using the classic "The Structure of Scientific Revolutions" by Kuhn. The history of the interaction of Christianity and Science is examined using the book, "God and Nature", which is a collection of current scholarship in this area. Modern text exegesis is explored using the book, "In The Beginning" by Blocher. A current treatise on the topic of this course, "Quarks, Chaos and Christianity" by Polkinghorne is also studied in detail.

66-307 Independent Study

All Semesters: 6-18 units

This course is intended for students with a special interest in an interdisciplinary area in the humanities and/or social sciences not covered by a normal course. Readings and other works are developed by the student and an individual faculty member. The number of units will be assigned at the time of registration based on the number of hours to be completed (decided in advance with the sponsoring faculty member).

66-320 Internship

All Semesters: 3-18 units

Internships-for-credit allow students to apply course-based knowledge in a non-classroom setting, under joint supervision and evaluation by an on-site supervisor and a faculty sponsor. Approved internships must conform to college guidelines for internships-for-credit, and are available by permission only arranged through the Associate Dean's Office in Baker Hall A57.

66-501 H&SS Senior Honors Thesis I

All Semesters: 9 units

This sequence is open only to those seniors who have been admitted to the H&SS Senior Honors Program. This is the first semester of a two-semester sequence that is designed as a readings course, and the second semester course as the culmination of an original, year-long independent research project. Research topics are selected by faculty and students.

66-502 H&SS Senior Honors Thesis II

All Semesters: 9 units

This sequence is open only to those seniors who have been admitted to the H&SS Senior Honors Program. This second semester course is the culmination of an original, year-long independent research project. Research topics are selected by faculty and students. Prerequisites: 66501

67-100 Information Systems Freshman Workshop

Fall: Mini Session - 1 units

This workshop is a discussion-oriented class that provides interaction between IS freshman students, their advisor, IS faculty and IS upperclassmen. Being a mini-course that meets in the second half of the fall semester, discussions will include students' progress in their college experience so far, as well as guidance for students in course planning, both for the online registration process for creating their spring semester schedule of classes and for their overall four-year plan.

67-101 Concepts of Information Systems

Spring: 6 units

The course provides an overview of the core concepts of information systems, and the impact of IS on the broader world. To this end, students will be exposed to the key concepts of people, process, and technology in information systems through lecture, case study, and project experience. Time in lecture will discuss topics such as the history of IS, the economics of information, as well as the key organizational and social issues. The class will study in detail the development of an IS project, and review some of the skills necessary for successful implementation of information systems. Finally, students will put these concepts into practice by working in small teams and using HTML, CSS, and javascript to create a website.

67-211 Introduction to Business Systems Programming

Fall and Spring: 6 units

This course is an introduction to the COBOL programming language. In addition to the basic syntax of the language, the course presents several information systems applications and discusses their solution in COBOL. COBOL is the most widely used language in the business community. New versions of COBOL for Unix and PC's have enhanced its status in the programming world. This class is a combination of lecture, readings, and programming. Students leave the course with an understanding of the COBOL syntax and the data file usage. The instruction emphasizes the importance of design and maintenance as well as coding in developing business applications.

67-250 The Information Systems Milieux

Fall: 9 units

Information systems (IS) are changing work practices, reshaping organizations, transforming cultures, and giving new meaning to the ways we see the world. This course is designed to help students understand the role of IS in modern society and the means by which these systems are created. It provides not only a framework for understanding information and information systems, but also a language to identify their dynamic complexities and interdependencies. Topics include: current trends in IS, structured approaches to the creation of IS, corporate IS competitive advantage, business process improvements/reengineering, eCommerce and the digital economy, knowledge management, decisions support systems, and the implications of IS for people, organizations and society. Classes will use a combination of lectures, class discussions, reading assignments, case studies, group projects, and "hands-on" work in database design. This course is a required professional core course for sophomores in the IS major. Non-IS sophomores may enroll by special permission.

67-271 Fundamentals of System Development I

Fall: 9 units

This is an introductory course in software systems analysis and design and project management. The course will cover contemporary themes and issues involved in developing high quality software systems that meet users' expectations. Students will learn the basic theory, techniques and skills that systems analysts need to develop and document requirements and project plans for complex information systems projects. Since software system development practice is a rapidly evolving area, a cross-section of current, as well as time tested best practices methods will be presented. The course consists of these main components: overview of systems analysis and design, lifecycle and process issues, requirements articulation with use cases, object models and diagramming and documentation tools and techniques, and project management, including issues of software quality and metrics. Concepts will be mastered through a combination of assigned readings, class attendance, homework assignments and mini-projects. Grades will be assigned by weighting assignments together with midterm and final examinations.

Prerequisites: 15111 or 15121 or 15200 or 15211

67-272 Application Design and Development

Spring: 9 units

This course provides students with the concepts and techniques to design and develop software applications, and to understand the design process. Students will learn the importance of user-centered design and will develop a prototype of a web application as a course project. In the process of developing the application, students will learn how to design and create relational databases, how to acquire competency in new programming languages quickly, how to use the Model-View-Controller pattern to develop software applications, how to ensure technical quality in software development, and how to apply principles of user-centered design. This course is a professional core requirement, and is open only to IS sophomores and juniors.

Prerequisites: 15111 and 67250

67-304 Database Design and Implementation

Spring: Mini Session - 6 units

This course provides an introduction to database design and implementation with a primary focus on the relational model. By the completion of this course the student will be able to appropriately use database design and implementation tools (the relational model, E-R models, normalization, and SQL) and apply knowledge of both technical and business issues related to database design and implementation to generate and evaluate alternate solutions to business situations. The course will also cover database dependability, reliability, availability, recovery, architectures, and distributed databases. Current topics in databases such as object-oriented and object-relational databases as well as data warehousing and data mining will also be presented. Projects will

be completed using a "significant" relational database management system such as Oracle, DB2 or Microsoft SQL Server. Prerequisites: 67271 and 67272

67-325 Special Topics: Global Systems Delivery Models

Fall: Mini Session - 6 units

Globalization and outsourcing of software services is now a mainstay of the business environment. The decision to outsource software services to providers in distant places has many risks and careful management of critical success factors is essential. As a result, students majoring in diverse areas such as information systems, business computer science, and many others will increasingly be involved as managers or technologists in projects engaging multiple providers and development teams in diverse locations. Management of these relationships will be an increasingly important skill for students expecting to fully participate in the emerging IT marketplace of the 21st century. This course introduces the business context and mechanics of outsourcing including offshore outsourcing. Students will learn how outsourcing works in practice and will study the associated economic, social, political and practical aspects. Students will also examine the effects of human diversity and cross-cultural considerations in the creation and use of information systems. Students must have sophomore standing or higher.

67-326 Global Project Management

Fall: Mini Session - 3 units

In an increasingly interconnected world, products and services will be developed and delivered by teams of people in diverse locations working together. This course is a 3-unit module intended to introduce students to the 'art' of project management across geographical and cultural boundaries. The course will cover the basics of effective project management, cross cultural communications and the pragmatic aspects of getting things done. This course is open to students in all majors and will be presented from a managerial point of view and not delve into technical aspects of project management. A combination short readings, participation in class discussion and a non-technical short collaborative project will be expected of class participants. Students must have sophomore standing or higher.

67-344 Organizational Intelligence in the Information Age

Fall: 9 units

Across all organizations people find that the actions they take affect, and are affected by, the technology, norms, procedures, culture, and members of the organization. In order to navigate through this organizational world, agents need a better understanding of social and organizational intelligence. How do organizations (and the people who populate them) acquire and then process information? In what ways have new technologies affected the norms, procedures, and culture of organizations? How do leaders successfully guide their organizations through a world where new information and new technologies are constantly being produced? This course is about information assessment and analysis in organizations, and the way organizations are transformed by technology.

67-366 Social Issues in Computing

Spring: Mini Session - 6 units

When people use electronic information systems to conduct social relationships, those relationships assume characteristics that are strongly influenced by the medium in which they are conducted. Although there is some understanding of these influences, the social context of computing is a relatively new area of study. This course will consider relationships in which electronic media, principally the information networks made possible by computers, provide a significant context for social and public engagement. The course will examine social issues arising in this context and explore various analytical perspectives on these issues. Among topics for consideration: (1) the Internet and personal identity; (2) influences of electronic media on individual and human rights; (3) effects of computing on personal and public security; (4) social justice in a digital environment; and (5) changes in personal lifestyles and work styles in a networked world. Classes will include lectures, discussion and group reports. One take-home, essay exam will be given. In addition, students will form a project team to research case studies and recommend public policy or other constructive social responses to issues arising in a world of pervasive electronic networking. This course is cross-listed with 88-366 (Dept of Social & Decision Sciences) and 05-499(Human-Computer Interaction). Prerequisite: Junior or senior standing.

67-371 Fundamentals of System Development I

Fall: 9 units

This is an introductory course in software systems analysis and design and project management. The course will cover contemporary themes and issues involved in developing high quality software systems that meet users' expectations. Students will learn the basic theory, techniques and skills that systems analysts need to develop and document requirements and project plans for complex information systems projects. Since software system development practice is a rapidly evolving area, a cross-section of current, as well as time tested best practices methods will be presented. The course consists of these main components: overview of systems analysis and design, lifecycle and process issues, requirements articulation with use cases, object models and diagramming and documentation tools and techniques, and project management, including issues of software quality and metrics. Concepts will be mastered through a combination of assigned readings, class attendance, homework assignments and mini-projects. This course is a professional core requirement, and is open only to IS juniors who have completed 67-272.

Prerequisites: 67250

67-373 Software Development Project

Spring: 12 units

This is a lab course providing experience working with a small project group to design and analyze a computer-based information system. To illustrate and provide practice utilizing the tools of structured analysis and design, the class is divided into groups which are assigned to analyze, design and build an information system.

Prerequisites: 67271 and 67272

67-390 Independent Study in Information Systems

All Semesters: 3-18 units

Independent studies are opportunities to engage in research with a faculty member to advance your learning in certain areas of interest. Information Systems students may enroll in independent study for 3, 6, 9, or 12 units of academic credit by obtaining a faculty sponsor who will oversee the academic component of the coursework, monitor progress, and assign a final grade.

67-475 Information Systems Applications

Fall: 12 units

In this course, students design and implement a usable information system for a client. The client may be affiliated with the university, government, business, or non-profit agency. Students will be assigned to teams to work on these projects, and will produce operational, fully documented and tested, computer-based information systems. The projects will be supervised by CMU faculty and, when possible, by project clients.

Prerequisites: 67373

67-501 Information Systems Honors Thesis I

Fall: 9 units

67-502 Information Systems Senior Honor Thesis II

Spring: 9 units

67-505 Information Systems Internship

Spring: 1-12 units

Physical Education**69-101 Racquetball**

Fall and Spring: Mini Session - 3 units

This course is designed to aid in developing the fundamental skills involved in racquetball. Techniques, rules and strategy are stressed. It is hoped that the student will develop a reasonable level of proficiency to enable participation on a leisure-time basis.

69-102 Weight Training

Fall and Spring: Mini Session - 3 units

This course is designed to provide the opportunity for the inexperienced student to learn the effectiveness of a carefully planned weight-training program as a method of body development and the contributing benefit to performance in many sports.

69-104 Integrated Strength Training

Fall and Spring: Mini Session - 3 units

This course improves functional strength, core strength balance, and functional flexibility.

69-105 Agility & Circuit Training

Spring: Mini Session - 3 units

This course is designed to train the entire body combining fitness

and core body work. We will do jumping and agility exercises to increase explosiveness and foot speed. Circuit training will be used to strengthen your core, arm, and leg muscles and will provide a cardiovascular workout.

69-107 Power Walking

Fall and Spring: Mini Session - 3 units

This course is an aerobic conditioning activity. A fast paced walk that is less wear and tear on your joints than what a running program will do.

69-108 Jogging for Fitness

Fall and Spring: Mini Session - 3 units

This course will be a jogging course prescribed partially by the individual with assistance from the instructor to insure that the desired results will be achieved or at least pursued correctly. Guidelines will be enforced, but individual goals will be the main concern. Stretching, health and nutrition will be discussed.

69-109 Karate

Fall and Spring: 6 units

The student begins the study of application of the basic techniques in combinations (continuous execution of techniques in succession). Basic sparring is also introduced, along with additional formal exercises (Katas).

69-110 Personal Fitness

Fall and Spring: Mini Session - 3 units

This course will be a conditioning course prescribed partially by the individual with assistance from the instructor to insure that the desired results will be achieved or at least pursued correctly. Individual goals will be the main concern. Stretching, aerobics, weight training and nutrition will be discussed.

69-112 Fitness Fusion

Fall and Spring: Mini Session - 3 units

A fun power-packed workout designed to introduce all aspects of fitness. This class combines simple exercises including cardio endurance with dynamic balance and stabilization. The class will fuse fitness while maximizing the benefits offered by training with concise, innovative, and effective exercises for the whole body. Every few weeks another aerobic activity will be added. We will start slowly so you can experience progressions and advance your training. During the fusion of strength, core, and flexibility, we will use a variety of "toys" to enhance your fun and fitness while fusing the total package of mind, body, and spirit.

69-128 Shaolin (Kung Fu) Temple Boxing

Fall and Spring: Mini Session - 3 units

Shaolin Temple Boxing trains the external aspects of Chinese Kung Fu which helps beginning students attain firm balance, flexibility, agility, good posture and stance work, proper mechanical and structural alignment, coordination, stability while moving, and a physically strong body. A well-rounded physical regimen will warm up the muscles and elongate the tendons for the Stationary Basic exercises, Walking Basics, and Kicking Basics, leading into Empty Hand Forms Practice and Sparring. Emphasis will be placed on knowledge fundamental techniques and power-issuing methods. These basic skills are practiced in the context of developing all aspects of the fighting arts such as foot and leg work, striking with all parts of the body; seizing and locking (qin na); and throwing (shuai jiao). The instructor is Marc P. Black.

69-129 Rape Aggression Defense Systems (RAD)

Fall and Spring: Mini Session - 3 units

Self Defense for Women - is a course specifically designed to increase women's awareness of potential sexual assault and to provide physical techniques to respond to such an act. It is intended for women only because it is believed that the presence of males in class (other than instructors or other authorized persons) can alter the emotional and physical responses of women to class material and thereby hinder their ability to reach course objectives. It is of the utmost importance that women be able to maximize their opportunity to learn in the company of like-minded students. The core of the course is based upon the principles of the Rape Aggression Defense System (R.A.D.) which was conceived and developed by Larry N. Nadeau. His goal in developing R.A.D. is also its motto: "To develop and enhance the options of self-defense, so they may become viable considerations to the woman who is attacked." This course is composed of three sections: risk reduction principles, physical defense techniques, and simulation. Risk reduction principles include a thorough review of personal self-awareness & the environment, whether in the home, neighborhood, or unfamiliar community. Physical defense techniques include the introduction to bodily strikes with hands, kicks with the feet, and

defenses against grabs & holds. Simulation is the activity that attempts to incorporate, via physical demonstration, all emotional & physical techniques that have been taught through the acting out of scenarios involving instructors (padded/protected) as attackers, and students (padded/protected) responding to the assault.

69-130 Beginning Tennis

Fall and Spring: Mini Session - 3 units

This course is designed to familiarize the student with the rules of tennis and to develop the skills needed to become proficient for recreational play. During the first half of the course, all tennis strokes will be covered and reviewed in detail. The second half of the course will focus mostly on competitive games and match-play.

69-131 Volleyball

Fall: Mini Session - 3 units

This course is designed to familiarize the student with the rules of volleyball and to develop the skills needed to become proficient for recreational play.

69-134 Beginning Golf

Fall and Spring: Mini Session - 3 units

This course is designed to give the student all the skills necessary to play a satisfactory game of golf. The long game, the short game and putting are covered. It is a leisure time sport that is challenging and can be used by the student for the rest of his/her life.

69-135 Soccer Skills

Fall and Spring: Mini Session - 3 units

This course is designed to familiarize the student with the rules of soccer and to develop the skills needed to become proficient for recreational play.

69-136 Basketball Skills

Fall and Spring: Mini Session - 3 units

This course is designed to familiarize the student with the rules of basketball and to develop the skills needed to become proficient for recreational play.

69-140 Squash

Fall and Spring: Mini Session - 3 units

This course is designed to aid in developing the fundamental skills involved in squash. Techniques, rules and strategy are stressed.

69-142 Beginning Fencing

Fall and Spring: 6 units

This course will cover the basic skills needed for fencing with the foil. Footwork, attacks, and defenses will be practiced. Competition rules and strategies will be discussed. Students will fence each other and the instructor in almost every class.

69-144 Diamond Sports

Spring: Mini Session - 3 units

This course is designed to familiarize the student with the rules of softball and wiffleball and to develop the skills needed to become proficient for recreational play. Students will play each other or the instructor in almost every class.

69-150 Beginning Swimming

Fall and Spring: Mini Session - 3 units

This basic course is designed to equip the non-swimmer with fundamental skills and knowledge to assure reasonable safety in, on or about the water. Areas covered include the basic swimming strokes, basic diving, safe and efficient entry into the water, and some elementary forms of rescue.

69-151 Introduction to Yoga

Fall and Spring: Mini Session - 3 units

This course is designed for the beginning yoga student who wants to gain a solid foundation of yoga poses and the benefits a yoga practice has to offer. The course is also for those who have experience in Yoga and want to practice and improve their basic skills. This class will be taught by Brian Dunn.

69-153 Lifeguard Training

Spring: Mini Session - 3 units

This course will be taught in two minis. In the first mini, the American Red Cross Lifeguard Training course material will be taught. Students who complete certification will be eligible to be employed as lifeguards. In the second mini, this course will be taught to current lifeguards who wish to recertify in the following: Lifeguarding, CPR/AED, and First Aid. Attendance is required. There will be a fee for this class from the American Red Cross. This fee will be deducted from the student's account once the status of the student is "enrolled and attending this class."

69-154 Intermediate Swimming

Fall and Spring: Mini Session - 3 units

This class is designed for the swimmer that can tread in deep water, has no fear of water, and would like to learn the proper techniques of the basic swimming strokes.

69-155 Aerobic Fitness/Sculpt

Fall and Spring: Mini Session - 3 units

A total body fitness class for men and women that incorporates stretching for flexibility, exercises for strength and movement to increase cardiovascular improvement.

69-156 First Aid/CPR

Spring: Mini Session - 3 units

A basic course in treatment and care of injuries in emergency situations. Topics will include legal liability, prevention of injuries, nutrition and cardiovascular conditioning. The course will conclude with theoretical and practical application of cardiopulmonary resuscitation. Upon completion of the course students will receive Red Cross Certification. There will be a fee for this class of \$10.00. This fee will be deducted from the student's account.

69-157 Swimming Stroke Improvement

Fall: 6 units

This course is designed to provide the student with the opportunity to learn the elements of good swimming. A wide range of strokes, basic diving, safety, endurance, and versatility in the water will be covered for all students. Experienced swimmers will have the opportunity to perfect their strokes.

69-158 Beginning/Intermediate Yoga

Fall and Spring: Mini Session - 3 units

A user-friendly style of yoga for the general population. In this course, you will discover new ways to move, breathe, stretch, and relax using traditional yoga poses. Participants will breathe better, move easier, and become more comfortable in everyday activities.

69-159 Aqua @ Both Ends

Fall and Spring: Mini Session - 2 units

Discover a great way to effectively train and smoothly blend excitement and fun with directional changes and multi-dimensional movement while working your heart, toning your muscles, and strengthening your core. Repeated bouts of exercise with intermittent rest periods challenging even the deepest muscle layers in your body. Participants are in either shallow or deep water. NO SWIMMING SKILLS REQUIRED! Buoyancy and resistance equipment supplied.

69-160 Swim-Fit

Fall: Mini Session - 3 units

You must know how to swim to take this class; this is not a learn-to-swim class. Pre and post timed swims, deep water treading, lap swimming interval training.

69-161 Beginning/Intermediate Yoga

Fall and Spring: Mini Session - 3 units

A user-friendly style of yoga for the general population. In this course, you will discover new ways to move, breathe, stretch, and relax using traditional yoga poses. Participants will breathe better, move easier, and become more comfortable in everyday activities.

69-162 Beginning/Intermediate Yoga

Fall and Spring: Mini Session - 3 units

A user-friendly style of yoga for the general population. In this course, you will discover new ways to move, breathe, stretch, and relax using traditional yoga poses. Participants will breathe better, move easier, and become more comfortable in everyday activities.

69-165 Indoor Cycling

Fall and Spring: Mini Session - 3 units

Indoor cycling classes are riding on a stationary bike while getting a great workout, experiencing several styles of training, and listening to music. All are welcome--beginner to advanced--you set the workout pace to various intensities. This course is for those participants who want to gain knowledge and experience of riding for endurance, speed work, race training, strength training, and/or visionary riding. Each class will be formatted to take the rider to their levels of advancement--beginner to advanced--all doing the same workout. Bikes are provided. No prior bike experience is necessary. No special footwear required--bike shoes are welcome--and tennis shoes at least are a must. Come along for the ride of a lifetime while having fun and getting into shape.

69-175 African-Caribbean Dance

Fall and Spring: Mini Session - 3 units

This class incorporates African-Modern dance technique (specifically elements of Dunham and Horton technique) and applies it to dance movements from West Africa, Haiti, and/or Brazil. Students will build strength, alignment, and stamina while experiencing the joy of dancing to the exciting and mesmerizing music of these regions. Open to non-drama and drama majors.

69-190 Managing Stress, Restoring Harmony

Fall: Mini Session - 3 units

This course is designed to explore the subject of stress and how it can be managed. Topics addressed include: the environmental, mental, and emotional components of stress, factors that affect the experience of stress, how stress contributes to illness, and an overview of various stress management techniques.

69-191 Health & Wellness Across the Spectrum

Spring: Mini Session - 3 units

This course, designed on the holistic model of health, will expose students to various health and wellness concepts, including complementary and alternative health practices as well as mainstream/western medicine. A broad range of healing philosophies, approaches, and therapies will be discussed. Students should complete the course with a greater knowledge of how to establish and maintain his or her optimal state of physical, emotional, and spiritual wellness.

69-193 Healthy Eating, Healthy You

Spring: Mini Session - 3 units

The college setting can present a challenging environment for healthy eating. Away from home for the first time, students are often exposed to a variety of food choices available at all times of the day and night. Regulating eating habits and making healthy food choices can become an overwhelming task. This course empowers students to develop and promote healthy eating and physical activity attitudes and behaviors for themselves. Critically evaluates current public health approaches, popular diets and supplements, stress and disordered eating, weight and body ideals, food industry practices, messages from peers, family, and the media, and self-destructive thoughts. This course is open to all students. The Registered Dietitian from Student Health Services will teach the course, Healthy Eating, Healthy You.

69-195 Emergency Medical Technician

Spring: 6 units

This course is designed to instruct a student to the level of Emergency Medical Technician-Basic. This includes all skills necessary for the individual to provide emergency medical service at a basic life support level with an ambulance service or other emergency service. Students who pass the state exam will receive Pennsylvania Accreditation as EMT-Basic.

Business Administration**70-100 Introduction to Business**

Fall: 9 units

This course examines the fundamental issues in the development of new markets for products and services globally. In addition, it provides a foundation for understanding the functional areas of business and how they contribute to management of a firm. Students use this foundation knowledge to analyze cases and complete projects in order to gain an understanding of some of the key issues affecting a wide range of the most important global industries. First year students can also gain a better understanding the vast array of career possibilities available to those who study business. This course is restricted to first-year business majors and students may not receive credit for both 70-100 and 70-101.

70-101 Introduction to Business Management

Fall and Spring: 9 units

This course examines the fundamental issues in the development of new markets for products and services globally. In addition, it provides a foundation for understanding the functional areas of business and how they contribute to management of a firm. Students use this foundation knowledge to analyze cases and complete projects in order to gain an understanding of some of the key issues affecting a wide range of the most important global industries. First year students can also gain a better understanding the vast array of career possibilities available to those who study business. This course is restricted to first-year business majors and students may not receive credit for both 70-100 and 70-101.

70-122 Introduction to Accounting

All Semesters: 9 units

This course provides the knowledge and skills necessary for the student to understand financial statements and financial records and make use of the information for management and investment decisions. Topics include an overview of financial statements and business decisions; the balance sheet, the income statement, and the cash flow statement; sales revenue, receivables, and cash; cost of goods sold and inventory; long-lived assets and depreciation, and amortization; current and long-term liabilities; owners' equity; investments in other corporations; an introduction to financial statement analysis and international issues dealing with financial statements.

70-160 Graphic Media Processes

Fall: 9 units

This course provides a foundation for the study of graphic communications management by investigating the processes and materials used in the graphic arts. The subjects examined include typography, papermaking, ink technology, electronic imaging, process control and color separation.

70-194 Publishing Management in the Information Age

Spring: 9 units

As the digital era transforms the publishing industry, this course addresses how best to manage the opportunities brought about by profound technological changes. The course focuses on the management of intellectual property, the publishing process, career opportunities and the impacts of new technologies. Lectures, guest speakers and student business simulations integrate learning.

70-201 Professional and Service Projects

All Semesters: 9 units

Professional service is important in career development because it creates opportunities to use skills and knowledge, develop leadership abilities, develop professional networks, and to learn the importance of community involvement and social values in business practice. Students complete a variety of activities with these objectives over a period of up to four-(4) semesters to satisfy this course requirement.

70-207 Probability and Statistics for Business Applications

Fall: 9 units

Elementary ideas in probability, statistics and data analysis presented in the context of their importance to modern business management.

Prerequisites: 21120 or 21121

70-208 Regression Analysis

Spring: 9 units

This class focuses on the statistical analysis of the relationship between two or more random variables. In particular, we examine the estimation of the conditional mean of the dependent variable as a function of independent variables using linear regression. We draw on statistical theory to determine the precision of our estimates and to conduct inference about the population, and we examine a number of applications to business, finance and economics throughout the course.

Prerequisites: (21212 or 21116 or 21112 or 21120) and (36201 or 70207 or 36310 or 36220 or 36247) and (73100 or (73110)

70-311 Organizational Behavior

Fall and Spring: 9 units

This course examines the factors which influence individual, group and firm behavior in the context of the workplace. Topics covered include perception, group behavior, decision making, motivation, leadership and organizational design and change.

Prerequisites: 76100 or 76101 or 76214 or 76236 or 76245 or 76327 or 76331 or 76347 or 82085

70-332 Business, Society and Ethics

Fall and Spring: 9 units

The course draws upon actual cases to explore fundamental questions faced by businesses operating in the United States and elsewhere in the world. What justifies governmental regulation of your business? What are the rights of employers and employees? How does the law protect consumers? What laws protect the environment? How do you choose the best legal form for your business? What are the lines of power within a corporation? What protections are available to shareholders? How do the antitrust laws protect competition? What responsibilities does a business have to the community in which it operates? What is the ethical foundation on which business ought to be conducted? The course puts businesses in their legal and ethical context.

Prerequisites: 76100 or 76101 or 82085

70-340 Business Communications

Fall and Spring: 9 units

Business Communications develops and sharpens your written, oral, and interpersonal communication, introducing you to common forms of professional writing and speaking in specific business situations. The course explores crucial rhetorical issues that impact your ability to communicate and achieve your objectives as a business leader. Prerequisites: 76100 or 76101 or 76104 or 82085

70-341 Organizational Communication

Fall: 9 units

Much of the work in groups and organizations consists of communication. You communicate to get information that will be the basis of decisions, to provide a vision for the people who work for and with you, to coordinate activity, and to sell yourself and your work. The goal of this course is to identify sources of communication problems within an organization and ways to overcome them. To do this requires that we know how communication normally works, what parts are difficult, and how to fix it when it goes wrong. The focus of this course is on providing you with a broad understanding of the way communication operates within dyads, work groups, and organizations. This course is not a practicum in public speaking or writing, although you will get some experience writing, speaking and managing impressions. Rather the intent is to give you theoretical and empirical underpinnings for the communication you will undoubtedly do when you return to work. Readings come from both the research and the managerial literatures. Among the topics considered are managerial communication, persuasion and conformity, self presentation and person perception, social networks. Cases and group projects give you an opportunity to apply what you've learned. Prerequisites: 36201 or 36207 or 36217 or 36220 or 36225 or 36247 or 70207

70-342 Managing Across Cultures

Spring: 9 units

This course is designed for students who expect to do business in other countries or work with people from other cultures. It provides an intellectual framework for understanding other cultures (and eventually one's own), as well as detailed studies of particular countries. It discusses how culture defines organizations, contracts, personal relationships, attitudes toward authority, time and space, ethics, wealth, and subcultures, and how these affect business. Student teams study a culture of their choice and make presentations, based on interviews and literature research. Prerequisites: 76100 or 76101 or 82085

70-343 Interpersonal Communication

Spring: 9 units

This course examines various types of interpersonal communication usually found in business situations. Topics covered will vary each semester, but can include business and social etiquette, ethics in business, dressing for success, interviewing skills, leadership skills, listening skills, how to run a successful meeting, intercultural communications, motivating employees, negotiating, networking in business, non-verbal communications, performance appraisals, power communication, telephone skills and team/small group communication. Co-curricular events will be required and may include conducting mock interviews, role playing business luncheons and navigating business social events.

70-345 Business Presentations

Fall and Spring: 9 units

In this course, students prepare, present, discuss, and critique the different oral presentations currently practiced in business. Topics include developing verbal and physical presence; planning presentations based on audience needs and expectations; projecting personal credibility, professionalism, and appropriate emotional responses; and using various multi-media technology. Assignments and cases will cover informative and persuasive presentations, which will vary from term to term and may include talks such as formal public introductions; explanations of policy and/or procedures; employee training sessions; state-of-the-company addresses; sales presentations; team-driven strategic plans; public interviews with a hostile press; and talks on other more free-ranging topics. Prerequisites: 70340 or 73270

70-350 Business Acting

9 units

This course provides a uniquely broadening educational experience for business students through an exploration & understanding of the process of Acting & the unique performer/audience relationship. Using techniques of Acting, the course will concern itself with: a new self-awareness & greater confidence in public communication; the

expansion & diversification of one's range of personal expression; methods to more effectively shape a public performance & of empowering the student to put his/her best Self forward when in contact with an audience; & a re-investment in passion.

70-364 Business Law

Fall and Spring: 9 units

The external political, social and legal environment of the firm and its managers. Legal and regulatory matters, United States and multinational, will be considered, including restrictive trade practices laws and regulations, acquisitions and mergers, licensing, franchising, officers' and directors' responsibilities and liabilities, manufacturers' responsibilities and liabilities, securities regulation, environmental protection, intellectual property, labor unions, trade associations, employee rights and duties, the attorney-client relationship; values in a business society; social implications of business policies, and corporate social responsibility. The effects of laws upon day-to-day business administration. Contracts, sales, commercial paper, the Uniform Commercial Code, credit transactions, bankruptcy, insurance, agency, partnership, incorporation and corporate governance. Prerequisites: 76100 or 76101 or 82085

70-365 International Trade and International Law

Fall: 9 units

The course discusses the international legal system and laws that affect international trade. It covers the Foreign Corrupt Practices Act, treaties and concessions, shipping and customs, appointment of foreign sales agents, resolution of trade disputes, international mergers and joint ventures, international competition law, UN sales convention, international trade organizations (IMF, WTO, World Bank, etc.) , risk insurance, cultural factors, international E-Commerce and intellectual property. Prerequisites: 73100 or 73110

70-366 Intellectual Property and E-Commerce

Spring: Mini Session - 6 units

This course covers the basics of doing business on the internet with emphasis on E-Commerce issues such as intellectual property, cyber squatting and commercial transactions.

70-371 Production/Operations Management

Fall and Spring: 9 units

This course is an introduction to production and operations management that covers both manufacturing and services. It deals with strategic issues (design of flexible supply), planning issues (capacity management), and operational issues (inventory management and information). The linkage between strategy and tactics will be emphasized. The students will learn concepts and tools that will help them to manage from the "boardroom" to the "toolroom." Prerequisites: (21257 or 21292) and (70207 or 36202 or 36310 or 36220 or 36247)

70-381 Marketing I

Fall and Spring: 9 units

An introduction to the nature and fundamentals of the marketing activity. Topics include an analysis of the economic factors influencing buyer behavior, marketing research, market segmentation, development of marketing programs (new product, price, advertising and distribution decisions), and international marketing. Prerequisites: 76100 or 76101 or 76214 or 76236 or 76245 or 76327 or 76331 or 76347 or 82085

70-391 Finance

Fall and Spring: 9 units

Students are introduced to a quantitative approach to evaluating the decisions of firms and individuals. Stress is placed on logic and analytical approaches to problems such as portfolio choice or capital structure. Students learn both to draw inferences from the prices observed in markets and also to apply the normative standards of present value rules, diversification, and asset pricing theories. The role of reputation and ethics in the development of trustworthy markets is also studied. Prerequisites: (70207 and 21257 and 70122) or (70207 and 21292 and 70122) or (21370)

70-397 Venture Capital Investing

Fall: 9 units

Angel investors and venture capitalists have become the most visible sources of investment in new businesses in the United States. This course examines the investment process from the viewpoint of the angel and venture investor, and provides the students with a framework of their investment process. The course comprises four sections: investment criteria and selection, due diligence,

deal structure and valuation, and post investment management. Students will be expected, in a team setting, to move a potential investment through its diligence, deal structure and valuation stages, and present investment recommendations. Guest speakers will supplement the course.

70-401 Management Game

Spring: 12 units

This course is designed to integrate the managerial concepts and techniques studied earlier in the curriculum and to focus on elements of organizational structure and behavior. Student teams assume the role of top management of firms competing in an international economy simulated by the Carnegie Mellon University Management Game. Each team is responsible to a Board of Directors comprised of alumni of the MBA program and business masters students. Emphasis is placed on the development and implementation of sound organizational decision structures as well as the formulation of effective competitive strategies. Prerequisites: (70121 and 70371 and 70381 and 70391) or (70122 and 70371 and 70381 and 70391)

70-414 Technology Based Entrepreneurship for CIT

Fall: 9 units

Technology-Based Entrepreneurship, primarily for non-Industrial Management students, includes most of 70-415 and assumes no background courses in business. Therefore it involves additional sessions in core concepts in business. Students with majors in science, technology, engineering, the humanities or the arts are exposed to fundamental concepts and issues in business and gain a basic understanding of functional areas such as accounting, finance, marketing, sales and organizational behavior.

70-415 Introduction to Entrepreneurship

Fall: 9 units

This course is designed primarily to provide an overview of entrepreneurship, develop an entrepreneurial frame of mind and learn the rudiments of how to differentiate an idea from an opportunity. Students come up with a business idea and explore its potential for becoming a viable business. They learn to do market research and experience first-hand the rewards and difficulties in dealing with people in the real world. They will meet entrepreneurs and business professionals as part of the course and learn how to make effective presentations — both written and oral. Other important aspects of the course include self-assessment to determine one's strengths and weaknesses, understanding the "magic" of leadership and gaining an entrepreneurial perspective on life.

70-416 New Venture Creation

Spring: 9 units

This course exposes students to the nuances of financing new ventures, getting them started legally and marketing their products or services. Students pull together all the ideas and information from different functional aspects of their projects into coherent and persuasive mini-business plans that serve as roadmaps for building their businesses; and useful instruments to find sufficient financing for the new ventures, so that they can convince the outside world that these opportunities are viable, with substantial potential for success. Prerequisite: 70-414 or 70-415 or 70-420 or 70-422 or 15-390

Prerequisites: 15390 or 70414 or 70415 or 70420 or 70421

70-417 Topics in Entrepreneurship

Fall and Spring: 9 units

An independent study course in which students work on a one-to-one basis with the instructor to study in depth particular topics in which they are interested. Topics can include family business, entrepreneurship or development of their mini-business plan into a full-blown business plan.

70-418 Financing Entrepreneurship Ventures

Spring: 9 units

This course addresses the financial issues facing entrepreneurs. Various sources of financing are covered including bootstrapping, angels, venture capitalists and others. Guest entrepreneurs are invited to class to discuss how they got sufficient funding at the various stages of building their companies. In addition, the venture capital industry is reviewed and issues involved in arriving at company valuations are discussed.

70-424 Corporate Financial Reporting

Spring: 9 units

This course is designed to strengthen your ability to correctly interpret financial statements and their accompanying disclosures. The course is aimed at anyone whose career might involve working with accounting data, and should be especially useful for those

interested in consulting and financial analysis. Throughout the semester we will discuss the key disclosure rules in the United States, the communication methods available to managers, managers' incentives and ability to exert discretion over reported earnings, and the interplay between a company's corporate strategy and its financial reporting policies and practices. The course revolves around a number of topics of recent interest to the business community including the quality of earnings, mergers and acquisitions, purchased R&D, post employment benefits, executive compensation, and intangible assets.

Prerequisites: 70122

70-428 Financial Statement Analysis

9 units

This course is about fundamental analysis using financial statements. We develop and apply technologies for understanding and identifying firm activities that generate shareholder value and for developing valuation benchmarks. The ultimate goal of such analysis is to aid the security valuation and risk analysis exercises. This course is intended to help students establish a good foundation and introduce students the basics of equity and debt analysis techniques.

Prerequisites: 70122

70-430 International Management

Spring: 9 units

This course uses the case method to examine the strategic and operational issues in management practice and decision-making that are important in operating a business that spans national borders. Topics include political and economic risk assessment, technology transfer, cultural analysis, negotiation, social responsibility, organization structure, supply chain management and trends in foreign direct investment and their impact on developing strategies for entering and becoming successful in international markets.

Prerequisites:

70-440 Corporate Strategy

Fall: 9 units

This course is designed to provide the student with a general management perspective and an understanding of the total business enterprise. It builds upon previous course work in functional areas and provides insights and analytical tools which a general manager should have in order to plan and implement successful business strategy. The student will analyze complex business problems and formulate realistic strategic solutions. Emphasis is placed on the practical application of business theory by the student in his/her business career.

Prerequisites: 70122 and 70371 and 70381 and 70391

70-451 Management Information Systems

Fall: 9 units

The objectives of this course are to provide students with basic knowledge of the technology used in computer-based information systems and to enable them to acquire the skills for analyzing how to manage this technology in business. There is a strong emphasis on how to become both an intelligent user of information systems and also an effective participant in the design process of these systems. Credit will not be allowed for both 70-451 and Information Systems, 88-200.

Prerequisites: 15100 or 15105 or 15111 or 15112 or 15120 or 15125 or 15127

70-453 Systems analysis and Design

Spring: 9 units

This course is designed to provide students with a basic understanding of how to develop and implement computer-based management information systems. Students will be introduced to a variety of system development concepts and techniques. These can include traditional approaches such as top-down or structured analysis, problem definition, feasibility analysis, enterprise analysis and data flow diagrams, as well as interactive and iterative development approaches such as prototyping and object-oriented concepts and techniques. The course also explores topics related to successful implementation of systems such as testing strategies, project management, user-oriented design and software maintenance. Students will work in teams to analyze, design and build a small information system.

Prerequisites: 70451

70-455 Information Resource Management

Spring: 9 units

The objective of this course is to explore information resources management issues from a managerial perspective. In this course students learn how information resources can influence and define corporate strategy, how to discover opportunities to gain competitive

advantages with information resources and how managers control the development and use of such information resources (covering topics such as end-user computing expert systems and privacy). Students also learn how to model and analyze corporate information needs, how database management systems serve to support those needs and how managers address significant issues concerning that support.

Prerequisites: 70451

70-456 Telecommunication and Network Management

Fall: 9 units

This course introduces students to telecommunication and computer network technologies. We discuss computer telecommunications, local area networks and wide area networks. Topics include the ISO reference model; network architecture; data communications; local area networks; and ISDN. Students will develop a project to demonstrate the impact of telecommunication technology in business.

Prerequisites: 70451

70-459 Web Business Engineering

Spring: 9 units

In this course students will learn how to set up a business on the Internet and how to use the Internet and other telecommunications technologies to tie businesses together to form "virtual business."

Prerequisites: 70451

70-460 Mathematical Models for Consulting

Fall: 9 units

This course introduces students to a wide variety of models and techniques used by consultants and decision-support software. It covers applications of linear and integer programming, fuzzy logic and fuzzy control, neural networks, constraint programming, Bayesian networks, influence diagrams, analytical hierarchy process and data envelopment analysis. Such heuristic methods as tabu search, simulated annealing, genetic algorithms, learning based methods, asynchronous teams and ant colonies are briefly discussed.

Prerequisites: 21257 or 21292

70-461 Real Time Decisions with Resource Planning Systems

Spring: 9 units

This course will teach students to solve complex problems involving real-time data using a tool that is commonly used within business, Enterprise Resource Planning (ERP) systems. Emphasis will be placed on operation problems that span the boundaries of multiple functional areas within a firm. Students who take this course will not only possess significant domain knowledge, but will also be able to assess how ERP systems fit strategically with a company's strategy.

Prerequisites: 21256 or 21257 or 21292

70-465 Information Technology Strategy

Spring: 9 units

Information Technology (IT) has fundamentally changed the ways firms are managed and deal with their customers and business partners. This course focuses on how Information Technology can be used to create value or obtain a competitive advantage, providing an overview of fundamental strategy frameworks, underlying technologies, and recent industry trends. The goal is to understand how Information Technology enables new strategies and how existing strategies adapt to innovations in IT. At the end of the course, students are expected to have an understanding of how to strategically use Information Technology and to identify and critically evaluate important changes and opportunities IT creates along the value chain.

Prerequisites: 70451

70-471 Logistics and Supply Chain Management

Spring: 9 units

During the course we will discuss the basic issues of Supply Chain Management like inventory management, risk pooling, network planning, and supply contracts as well we some of the more concurrent issues. In the face of a globalizing economy we will discuss procurement and outsourcing strategies, global logistics and risk management. As supply chains generally cross firm boundaries we will look at supply chain integration, and alliances from a supply chain perspective. Also, as more and more information can be gathered about customers you will learn how to judge the value of this information and whether or not one should adopt a customer specific pricing model. The above issues will be covered at a general strategic level but whenever possible you will also learn how to quantitatively make trade-offs between alternatives.

Prerequisites: 70371

70-474 Quality Principles and Techniques

Spring: 9 units

The goal in this course is twofold: (i) to develop a high-level understanding of the ideas and philosophies concerning quality in business processes; and (ii) to develop expertise with the tools used to evaluate and improve quality. The goal of the course is not to indoctrinate students into any single quality assurance framework, but rather to teach them the techniques that are common, and central, to any effective quantitative quality design and maintenance program. Applications involve both manufacturing and services; we will examine financial services in some detail. We will conclude with a discussion of the core concepts of Six Sigma.

Prerequisites:

70-480 International Marketing

Spring: 9 units

This course is designed to provide students with a basic understanding of global marketing opportunities, key issues, and strategies. It introduces the main characteristics of international markets and addresses the impact of global environmental factors (economic, social, legal, and cultural) on marketing decisions such as market entry, product development, pricing, promotion, and distribution. The objective of the course is to help students acquire knowledge of major international marketing concepts and develop cross-cultural sensitivities and skills that would enable them to identify, analyze, and solve international marketing problems.

Corequisites: 70-381

70-481 Marketing Research

Spring: 9 units

The purpose of this course is to teach multiple research techniques used in marketing. This course is an applied marketing course that gives insight into how various techniques are used in marketing research firms. There are three projects and a final. The first project is designed to teach students about research survey methods. The second is an experiment in which the whole class is involved. The third, an individual project, is designed to teach quantitative research techniques.

Prerequisites: 70208 or 70381 or 73360

70-483 Advertising and Marketing Communications

Spring: 9 units

A brand's first contact with its customers is through marketing communications. Marketing strategy and execution is dependent on integrated marketing communications. Whether by advertising and sales promotion or new media and approaches, marketing communications is a major influence on business performance and culture and must be managed effectively by marketers. This course covers the role and execution of advertising and marketing communications as it relates to overall marketing strategy. Advertising, promotions, sponsorships, public relations, direct marketing, licensing, point of sale are explored in an advertising agency context. Student teams apply their understanding of these marketing communications tools to a real client situation, acting as an advertising agency team that develops and presents an integrated marketing communications campaign plan to brand managers and advertising agency executives at the end of the course.

Prerequisites: 70381

70-485 Product Management

Spring: 9 units

In this course you will progress through a series of roles, from product assistant to group product manager, that give you the opportunity to experience what is like to do product and brand management. Through interactive lectures, case discussions and assignments, you will learn how to conduct analysis and make decisions that face product managers in industry. This course covers consumer and business to business marketing, including brand strategy, new product introduction, pricing and product line profitability, distribution strategy, marketing communications integration, and brand/product portfolio management. Time is also spent on building effective internal, cross-functional and external customer and agency relationships. By progressing through case-based roles from product/brand assistant to group brand/product manager, you will learn the principles of product and brand management and understand what it is like, and what it takes, to be a successful marketing leader.

Prerequisites: 70381

70-486 Pricing

Spring: 9 units

The purpose of this course is to present a framework for assessing pricing decisions, the central element of marketing. The course is structured around marketing's three C's: Costs; Customers; and

Competitors. In the first part of the course we discuss how costs should, and should not, enter the pricing decision. We move on to show how a marketing focus on the customer provides insight into the pricing decision. Then we discuss how competitors impact the pricing decision. The course concludes with pricing strategies, tactics and their applications: dynamic pricing over the product life cycle, product line pricing through the marketing channel, price bundling and legal aspects of pricing.

Prerequisites: (70381) and (73100 or 73110)

70-488 Interactive Marketing

All Semesters: 9 units

In this course we analyze what happens to marketing practice when cheap and powerful computers and communication networks are used to mediate markets. This course focuses on several areas where the presence of computers and networks are likely to have the most profound affect on the field of marketing. These areas include branding, promotion, competitive strategy, channel conflict, pricing and marketing information goods, and identifying and differentiating customers. We will use both lectures, cases, and analysis of real-world datasets to analyze these issues.

Prerequisites: 70381

70-492 Investment Analysis

Spring: 9 units

Students build a strong foundation in Modern Portfolio Theory as well as equilibrium and no arbitrage approaches to asset pricing. Common stocks and fixed income securities (including mortgage-backed securities) are the principal markets of interest, with tangential coverage of forward, option, and currency markets. Empirical projects entail applications of trading strategies, portfolio management, and the characteristics of financial market data.

Prerequisites: 21370 or 70391

70-495 Corporate Finance

Fall and Spring: 9 units

Students develop an advanced financial perspective on how firms make investment, financing, and management decisions. The course starts with simple net present value rules and builds the theoretical framework to address more sophisticated issues and problems including risk management, mergers, acquisitions, executive compensation, corporate governance, and dividend payout policies. Theory is supplemented with numerous case study examples.

Prerequisites: 21370 or 70391

70-497 Options

Fall: 9 units

In this course students will learn to evaluate contingent claims such as options, futures, swaps and other exotic securities. In addition to covering canonical valuation formulae for standard option and future contracts, students will use numerical simulation methods to evaluate more exotic securities. The course will also cover various aspects of using derivative securities for risk management purposes.

Prerequisites: 70492

70-498 Futures and Swaps

Spring: 9 units

This course provides an introduction to important practical uses of futures and swaps in speculation, hedging and arbitrage. That is, it will provide you with an introduction to modern financial engineering using futures and swaps. A secondary goal is to introduce you to the various techniques, involving these instruments, used to manage the changing market and credit risk faced by a modern global financial institution. Emphasis is placed upon real world practical examples and learning from actual trading experience. The course will use this framework to draw out the important theoretical ideas that underlie these examples.

Prerequisites: 70391

70-499 Internship

All Semesters: 1-18 units

BA students are strongly encouraged to undertake internships. Students doing an internship of an academic nature do so under the supervision of a faculty member and receive a letter grade. Non-academic internships are possible for pass-fail credit with the approval of the Department Director. Enrollment by permission of the BA Program.

70-500 Honors Thesis I

Fall and Spring: 3-18 units

Business students with outstanding academic records may undertake an Honors Thesis. The topic is of the student's choice but must have some original aspect in the question being explored, the data set, or in the methods that are used. It must also be of

sufficient academic rigor to meet the approval of a faculty advisor with expertise in the project's area. Students enroll each semester in a 9-unit independent study course with their faculty advisor for the project (70-500 in the fall and 70-501 in the spring). Students and their faculty advisor develop a course description for the project and submit it for approval as two 9-unit courses to the BA department. Enrollment by permission of the BA Program.

70-501 Honor Thesis II

Spring: 3-18 units

Business students with outstanding academic records may undertake an Honors Thesis. The topic is of the student's choice but must have some original aspect in the question being explored, the data set, or in the methods that are used. It must also be of sufficient academic rigor to meet the approval of a faculty advisor with expertise in the project's area. Students enroll each semester in a 9-unit independent study course with their faculty advisor for the project (70-500 in the fall and 70-501 in the spring). Students and their faculty advisor develop a course description for the project and submit it for approval as two 9-unit courses to the BA Director. Enrollment by permission of the BA Program.

70-502 Independent Study in Management

All Semesters: 3-18 units

Students with a special interest in Management/Production not covered by a formal Business course may develop an Independent Study Course in that area. Readings and work to be completed are by agreement between the student and an individual faculty member. Enrollment by permission of the BA program.

70-503 Independent Study in Marketing

All Semesters: 3-18 units

Students with a special interest in Marketing not covered by a formal Business course may develop an Independent Study Course in that area. Readings and work to be completed are by agreement between the student and an individual faculty member. Enrollment by permission of the BA Program.

70-504 Independent Study in Organizational Behavior

All Semesters: 3-18 units

Students with a special interest in Organizational Behavior not covered by a formal Business course may develop an Independent Study Course in that area. Readings and work to be completed are by agreement between the student and an individual faculty member. Enrollment by permission of the BA Program.

70-505 Independent Study in Finance

All Semesters: 3-18 units

Students with a special interest in Finance not covered by a formal Business course may develop an Independent Study Course in that area. Readings and work to be completed are by agreement between the student and an individual faculty member. Enrollment by permission of the BA Program.

70-506 Independent Study Management Information Systems

All Semesters: 3-18 units

Students with a special interest in Management Information Systems not covered by a formal Business course may develop an Independent Study Course in that area. Readings and work to be completed are by agreement between the student and an individual faculty member. Enrollment by permission of the BA Program.

70-507 Independent Study in Business Communications

All Semesters: 3-18 units

Students with a special interest in Business Communications not covered by a formal Business course may develop an Independent Study Course in that area. Readings and work to be completed are by agreement between the student and an individual faculty member. Enrollment by permission of the BA Program.

70-635 Desktop Publishing

Spring: 9 units

This course presents a variety of topics related to desktop publishing in a hands-on laboratory environment. The topics covered include PostScript, file formats, fonts, trapping, illustration programs, image processing programs, page assembly programs, imposition, preflighting, output issues to films, plates, or disk and an introduction to new media.

70-637 Interactive Media Design Management

Fall: 9 units

Applications of computer systems in creating and managing electronic print and new media projects, with emphasis on the latter in creating effective communication pieces. Goals are the ability to use desktop publishing applications, animations and authoring

applications, and the ability to input and use different types of information, including text, photographs, illustrations, animations, sound effects and voice.

70-641 Color Reproduction and Management
Spring: 9 units

This course presents an in-depth view of the issues and technologies related to color reproduction. The theory, perception, specification and measurement of color are presented. Color separation techniques, color proofing, color management and the control of color production are all considered. Special effects and color manipulation are examined.

70-643 Publishing on the World Wide Web
Fall and Spring: 9 units

This course addresses topics related to the rapidly evolving area of WWW publishing, which has moved into the mainstream. Today, virtually every major newspaper, magazine, and book publisher has an active website. In addition, the Internet is used as a publishing medium by millions of other individuals and companies. In this course, the rush to WWW publishing is studied in context of the evolution of the internet; the lure of interactivity; the maturing desktop publishing revolution; and the continued development of tools and standards that lower the barriers to entry. The lecture topics encompass the history, technology, business applications and the design of materials to be published on the web. The course includes a lab component where the students perform individual and group projects to improve their design and applications skills.

70-650 Independent Study: Graphic Communications Management
All Semesters: 3-18 units

Students with a special interest in Graphic Media not covered by a formal Business course may develop an Independent Study Course in that area. Readings and work to be completed are by agreement between the student and an individual faculty member. Enrollment by permission of the BA Program.

Economics

73-100 Principles of Economics
All Semesters: 9 units

Literally, an introduction to economic principles, the goal of this course is to give students an understanding as to what constitutes good "economic thinking". This thought process is grounded in the construction and use of economics models. Drawing on issues in both microeconomics and macroeconomics, fundamental principles are shown to transcend particular examples and allow the field to be seen as a coherent, unified whole. (Lecture, 2 hours; Recitation, 1 hour).

73-101 Freshman Seminar
Fall and Spring: 9 units

A topics-based course for first-year students who intend to major in economics. The subjects discussed vary from year-to-year and from instructor-to-instructor. Check with the Undergraduate Economics Program or their website for descriptions of recent and current offerings. (Seminar, 3 hours)

73-111 Internship I
All Semesters: 1-3 units

By permission of the Undergraduate Economics Program.

73-112 Internship II
All Semesters: 3 units

By permission of the Undergraduate Economics Program.

73-113 Internship III
All Semesters: 3 units

By permission of the Undergraduate Economics Program.

73-148 Environmental Economics
Intermittent: 9 units

A course for non-majors which explores the interplay between economics and environmental issues. Topics include: market failures and environmental problems, economically efficient allocations of environmental resources, and the intended and unintended consequences of public policies designed to improve the environment. Practical issues surrounding the feasibility of implementing theoretically efficient principles and policies are analyzed, and alternative policies that might achieve better results in practice are investigated. (Lecture, 3 hours) Prerequisites: 73100

73-150 Microeconomics
Fall and Spring: 9 units

This course is a calculus-based introduction to microeconomics. Topics in partial equilibrium analysis include supply and demand,

consumer theory, theory of the firm, profit maximizing behavior, monopoly theory, and perfect competition. The course concludes with an introduction to general equilibrium analysis and the welfare laws. (Lecture, 3 hours; Recitation, 1 hour)
Prerequisites: 73100 and 21120

73-200 Macroeconomics
Fall and Summer: 9 units

Through macroeconomic models built upon microeconomic foundations, insights are developed into economic growth processes and business cycles. Topics include aggregation and measurement, national income, business cycle measurement, economic welfare theorems and social inefficiencies, the effect of government fiscal policy upon employment and productivity, and the relationship between investment, interest rates and economic growth. (Lecture, 3 hours; Recitation, 1 hour).

Prerequisites: 21120 and 73150 Corequisites: 21-259, 21-256

73-226 Quantitative Economic Analysis
Spring: 9 units

Using and extending upon students' introductory knowledge of probability and economic models, this course introduces students to the tools of economic analysis. Taking the perspective of active economic participants (rather than outside observers), students gain experience with a diversity of analytical techniques--such as regression analysis and simulation--in the context of real world data decision problems. Classes consist of a combination of cases, lectures, and interactive discussions. This course will not be offered after Fall 2009. (Lecture, 3 hours)
Prerequisites: 21256 and (73150 or 73200 or 73251) and (21325 or 36207 or 36217 or 36225 or 36310 or 70207)

73-251 Economic Theory
Fall and Spring: 9 units

This course prepares students for advanced coursework in economics by providing a mathematically intensive overview of economic theory. Students take advantage of their knowledge of multi-dimensional calculus and constrained optimization techniques in order to understand the development and logical consistency of the most commonly employed economic models. Topics include consumer preferences and utility function representations, consumer choice under a budget constraint, substitution and income effects, compensated and uncompensated demands, expected utility theory, risk and insurance, technology and production functions, cost minimization, profit maximizing firms, perfect competition, single-firm markets, game theoretic analysis of markets with few firms, introduction to general equilibrium models and the welfare laws. Course will be replaced by 73-252/253 in Spring 08.
Prerequisites: (21256 or 21259) and 73100

73-252 Advanced Microeconomic Theory
Fall and Spring: Mini Session - 6 units

This course provides a mathematically intensive overview of advanced applications of microeconomic theory. Topics include: Marshallian and Hicksian demands, indirect utility functions, substitution/income effects and the Slutsky equation, expected utility theory, risk and insurance, game theory, principle/agent problems, oligopoly, and general equilibrium theory. (Lecture, 3 hours) Course will be offered in Spring 08.
Prerequisites: 73150 and 21122 and (21256 or 21259)

73-253 Advanced Macroeconomic Theory
Fall and Spring: Mini Session - 6 units

This course provides a mathematically intensive overview of advanced applications of microeconomic theory. Topics may include: Solow and neo-classical growth models, the role of money and its effect on the economy, and the over-lapping generations model. (Lecture, 3 hours) Course will be first offered in Spring 08.
Prerequisites: 73200 and 73252 and 21122 and (21256 or 21259)

73-261 Econometrics
Fall: 9 units

This course takes as its starting point ordinary-least-squares estimation and the linear regression model, which are presented utilizing vector and matrix notation. This is followed by the application of OLS to non-linear models. Cases are then considered where the various assumptions of OLS do not hold and what corrective actions should be taken. Topics include: nonlinear-least-squares, two-stage estimation, instrumental variables, simultaneous equations, maximum likelihood estimation, and logit/probit models. (Lecture, 3 hours)
Prerequisites: 15100 and 21122 and (21256 or 21259) and 73226

73-270 Writing for Economists

Fall and Spring: 9 units

A writing course specifically designed for third-year Economics majors and additional majors. Students gain experience with technical writing techniques and skills needed for both their senior thesis and their eventual professional careers. The course emphasizes both individual and group projects. (Lecture, 3 hours)
Prerequisites: 73200 and 76101

73-310 History of Economic Ideas and Analysis

9 units

This course will be organized around the study of several central topics in the development of economics such as: the "invisible hand;" classical analysis of trade, value, and income distribution; the marginalist revolution; general equilibrium theory; classical monetary economics; Keynesian macroeconomics; and recent trends in theory and empirical analysis. Wherever possible, examination of the contemporary policy issues motivating major analytical developments will be included.

Prerequisites: (21256 or 21259) and 73200

73-325 Strategic Behavior in Non-cooperative Games

Intermittent: 9 units

Combining non-cooperative game theory and its experimental methods in a computer laboratory environment, this course teaches students how to develop and test models of social and business interactions. Both extensive and normal form game are treated in depth, including the concept of Nash equilibrium and its refinements. In the latter part of the course, students design, run and analyze their own experiments, and do individual experimental/research projects. (Lab/Lecture, 3 hours)

Prerequisites: 73150

73-340 Labor Economics

Intermittent: 9 units

This course uses economic theory and data to analyze topics such as: (1) individuals decisions about hours of work, investment in training or education, and choosing an occupation; (2) firms decisions about hiring, training workers, and setting wage rates; and (3) the resulting wage and employment outcomes as influenced by union contracts and implicit employment contracts. Also considered are public policy recommendations concerning minimum wages, job training programs, hazards on the job, race and sex discrimination, and income inequality. (Lecture, 3 hours)

Prerequisites: 73150

73-347 Game Theory for Economists

Intermittent: 9 units

An introduction to the theory of non-cooperative games with an emphasis on economic applications. After an initial examination of two-person, zero-sum games, the notion of a Nash equilibrium in an n-person, non-cooperative game is considered. Existence of and refinements to the equilibrium concept are discussed in the context of both normal and extensive form games. Economic applications may include various topics, including Cournot and Bertrand oligopoly models, general competitive exchange equilibrium, and free rider problems. (Lecture, 3 hours)

Prerequisites: 21122 and (73150 or 73251)

73-351 Public Finance

Intermittent: 9 units

This course examines problems created by market failure and analyzes the incentives and institutions, which can be used to alleviate these problems. We will consider applications such as education, environmental issues, defense, crime, and common resources. The common thread in these situations is that individual optimizing behavior does not necessarily lead to an outcome, which is optimal for the society. We will evaluate possible solutions involving private, informal mechanisms as well as those requiring public sector interventions. (Lecture, 3 hours)

Prerequisites: 73150

73-352 Public Economics

Intermittent: 9 units

In this course, students analyze the role of governments in market economies and their impact on the behavior and welfare of citizens. Reasons for government intervention in markets are examined in light of some of the economic challenges faced by modern societies in an increasingly globalized marketplace. Topics include: taxation and expenditure policies, externalities and market failure, social security, public assistance and income redistribution programs. There will also be some coverage of the role of local governments in the economy with respect to such issues as crime, urban development and education. (Lecture, 3 hours)

Prerequisites: 73200 and (73251 or 73252)

73-357 Regulation: Theory and Policy

Intermittent: 9 units

Government regulations touch almost every aspect of our lives – from our healthcare and work environments, right down to the food we eat and the air we breathe. Using an analytical framework that encompasses economic, political, and bureaucratic forces that create and shape them, this course explores the origins, goals, and implementation of many major regulations. Areas of regulation specifically examined might include air pollution, auto safety (air bags), food additives, technological risk (nuclear reactors), occupational safety (asbestos, cotton dust), hospitals, airlines and trucking, and consumer protection (truth in advertising). (Lecture, 3 hours)

Prerequisites: 73251 or 73252

73-358 Economics of the Environment and Natural Resources

Intermittent: 9 units

Fall or Spring A advanced course on the allocation of environmental and natural resources. Topics include: externalities and the misallocation of resources, examining the efficiency/inefficiency of markets for non-renewable resources, intended and unintended consequences of regulatory and tax policies, and modern alternative to regulation – such as the creation of new markets and property rights for environmental resources. (Lecture, 3 hours)

Prerequisites: 73150 or 73251

73-359 Benefit-Cost Analysis

Intermittent: 9 units

Fall or Spring The evaluation of public private sector projects. The theory of benefit-cost analysis and related techniques, such as cost-effectiveness analysis. Attention is given to such issues as valuing goods and services that are not normally traded in the marketplace (e.g., the value of an individual's life) and the social rate of discount. Applications are considered in detail. (Lecture, 3 hours)

Prerequisites: 73150

73-365 Industrial Organization

Intermittent: 9 units

Fall or Spring This course is concerned with the economic analysis of industrial markets that are not perfectly competitive. The effects of imperfect competition on firms' decisions (pricing, location, advertising, research and development, among others) are reviewed. Implications of these effects in terms of public policy are also discussed from a variety of perspectives. Finally, applications to actual markets are considered. (Lecture, 3 hours)

Prerequisites: 73251 or 73252

73-371 International Trade and Economic Development

Intermittent: 9 units

This course examines the economic rationale for trade among nations and its consequences for global economic development. Topics include: comparative advantages among nations, the free trade versus protectionism debate, and the effects of special trade agreements, free trade zones, and transnational economic unions. (Lecture, 3 hours)

Prerequisites: 73200 and (73150 or 73251)

73-372 International Money and Finance

Intermittent: 9 units

Fall or Spring The course concerns itself with the determination of real, monetary, and financial aggregates and the policies that influence them in an international context. Topics include: monetary policy and its effects on employment and inflation, the role of the banking system in the transmission of monetary policy, credit markets, banks as financial intermediaries, and the effect of domestic policies on international trade and financial markets.

Prerequisites: (73150 or 73251) and 73200

73-390 Behavior in Games, Auctions, and Markets

Intermittent: 9 units

This course examines models describing economic/strategic behavior in environments where the usual "perfectly rational agents" paradigm does not capture observed phenomena. Topics include: decisions and the endowment effect, heuristics and biases in decision making, overconfidence and under-confidence effects, myopia and under-saving, public goods games, learning and reputation in repeated games, fairness and reciprocity in labor markets, asset markets and the bubble mystery, the winner's curse in auctions, and optimal contract design..

Prerequisites: 73251 or 73252

73-392 Financial Economics

Intermittent: 9 units

Fall or Spring A rigorous quantitative course covering the economic fundamentals of financial markets. The course covers individual

decision making about saving and investment under uncertainty, and the equilibrium determination of asset prices for both complete- and incomplete-market settings. In addition, the course will cover topics in corporate financial decision making and the micro-structure of financial markets.

Prerequisites: (73150 or 73251) and 73226 and 21122

73-395 Independent Study in Economics

All Semesters: 1-18 units

The Independent Study course in economics allows the student to pursue his or her own research interests in any of a variety of topics in economics. A typical independent study course involves a semester long project under the supervision of an appropriate faculty advisor. The nature and scope of the project are determined by the student and faculty advisor.

Prerequisites: 73150

73-410 The Economics of Business Cycles

Intermittent: 9 units

The purpose of this course is to educate the student in modern business cycle theory. The first part of the course surveys the empirical regularities, which comprise fluctuations in aggregate economic activity, which economists have labeled business cycles. The second part of the course discusses the existing macroeconomic models, which students have learned in intermediate macroeconomics, while the third part of the course examines the policy implications of these models and the inadequacies of the models as economic explanations of cycles. The final part of the course discusses rational expectations models of the business cycle in considerable detail. The empirical implications of these new models are examined, and their policy implications are assessed. (Lecture, 3 hours)

Prerequisites: 73226 and 73253

73-420 Monetary Theory and Policy

Intermittent: 9 units

This course is concerned with various topics in monetary and macroeconomics including anticipated inflation, hyperinflation, output effects of monetary policies, alternative techniques of monetary policy implementation, and the interaction of monetary and fiscal policy strategies. Analysis of these issues is conducted by means of simple by explicit dynamic models incorporating rational expectations. In addition, attention is devoted to alternative types of monetary systems – commodity vs. paper money, for example. This segment of the course includes some consideration of issues relating to a technologically advanced society in which transactions are carried out by means of a computerized economy-wide bookkeeping system, rather than by money. (Lecture, 3 hours)

Prerequisites: 73200 and (73251 or 73252)

73-422 Real Estate Economics and Finance

Intermittent: 9 units

The principle objective of this course is to analyze the financial characteristics of real assets and their derivative products, as well as to provide an introduction to their associated institutions. Topics include: residential real estate markets, urban land markets, analysis of mortgages and mortgage markets, commercial property markets, financial valuation of real assets, influence of debt financing on risk and returns, innovations in real estate capital markets, and analysis of asset allocation decisions. (Lecture, 3 hours)

Prerequisites: 73150 or 73251

73-426 Advanced Quantitative Economic Analysis

Intermittent: 9 units

This course builds on the concepts developed in 73-226 and 73-261 and provides an introduction to advanced economic analysis at the undergraduate level. The main objectives of the course are: to provide a solid core of analytical and conceptual tools that students can use directly in their research; to give students an understanding of both the classic theory and some of the recent advances; to enable students to perform analysis by structuring the problem as a formal model and performing analysis of which yields useful predictions and insights. (Lecture, 3 hours)

Prerequisites: 73226 and 73261 and (73251 or 73252)

73-428 Markets for Energy

Intermittent: 9 units

This course offers students a broad survey of the oil, natural gas, and electric-power industries, with a particular focus on their transformation from vertically-integrated, regulated entities to organizations participating in open markets and on the role of new technologies which enabled these changes. Topics include: economics of resource extraction, volatility in futures markets for oil and natural gas, the rise and fall of OPEC, power systems

engineering and economics, and wholesale markets for electric power.

Prerequisites: (73150 or 73251) and 73226

73-432 Economics of Education

Intermittent: 9 units

In this course we examine economic issues related to education, particularly at the elementary and secondary level. In exploring why we care about education, we examine the private returns to education (those that accrue to the individual) and the social returns (those that accrue to society), and how social returns provide one rationalization for government's involvement in education. After an overview of basic facts related to the provision of elementary and secondary education in the United States, we turn to the issue of how education is produced. We study the role of financial resources, teachers and peers in the production process, and examine evidence on the effectiveness of public vs. private schools. In the face of evidence that public schools in the United States do not fare well in international comparisons, one response has been to give parents greater choice of schools for their children. This leads us to study the most prevalent school choice mechanism (choosing where to live), as well as charter schools and private school vouchers. Another response has been the movement to hold public schools accountable, of which the No Child Left Behind legislation is an example. Thus, we examine issues on accountability theory and practice. The concern remains, however, that even if elementary and secondary education were significantly improved through various mechanisms, the cognitive ability of some children would already lag behind by the time they start school due to their early childhood experiences. In this spirit we analyze evidence on early childhood interventions for disadvantaged children. Building on our understanding of educational outcomes through high school, we finalize with an overview of the market for higher education, with an emphasis on college pricing and admission decisions. Throughout we use microeconomic analytical tools, and we examine empirical evidence that applies econometric techniques.

Prerequisites: 73150 and 73226

73-435 Economics of Negotiations

Intermittent: 9 units

The objective of this course is to understand the influence of economic factors upon both the conduct of involved parties and upon their anticipated outcomes. Insights gained from economic analysis are used to help find profitable negotiation strategies and to help evaluate opportunities which depend upon a negotiated outcome. Topics include: the creation and allocation of economic value; the negotiator's fundamental decision problem; the tension between creating and claiming value; strategies for better agreements; the role of coalitions in multi-party negotiations; negotiations within and between organizations. Considerable emphasis will be placed on negotiation exercises, role playing, and on student discussion and analysis of actual current and past negotiation situations. (Lecture, 3 hours)

Prerequisites: 73150 and 73226

73-440 Auctions and Markets

Spring: 9 units

Fall or Spring This course investigates auctions and markets. Part analytical, part experimental, and partly data driven, it shows how the outcomes of different auction and trading mechanisms depend on the characteristics of the bidders and traders, the bidding or trading rules, and the information that the traders have. The course makes extensive use of Comlabgames to simulate the various types of auctions and markets we analyze. It is divided into four roughly equal parts. Part 1 is an introduction to limit order markets, and a detailed study of auctions, arguably the simplest market form. Part 2 extends our analysis of auction to monopoly, which differs from the simplest auctions because multiple units are sold and the monopolist can restrict sales. In he third part we investigate the effects of adding sellers and buyers to both sides of the market. Finally we extend our analysis to multi-market settings, such as stock exchanges, and use the concept of competitive equilibrium to predict behavior in limit order markets. (Lecture, 3 hours)

Prerequisites: 73150

73-458 Money, Banking and Financial Markets

Intermittent: 9 units

Fall or Spring This course will help the student to understand the interaction of real, monetary, and financial macroeconomic variables and the policies that influence them. In the first half of the course we study the joint determination of aggregate output and the real interest rate in a modern model of monetary policy. We see how interest rate policy offsets fluctuations in employment and inflation that otherwise would arise due to macroeconomic shocks. And we see why inflation targeting is welfare-maximizing monetary policy.

We describe how the Federal Reserve thinks about interest rate policy in practice with reference to the policy record from the late 1970s to the present covering: the "inflation scare" problem, the Volcker disinflation, the Greenspan era, and the case for inflation targeting in the US. The second half of the course shifts the focus to money, credit, and banking. We address money as the medium of exchange, credit in the exchange process, and the role of banks in the payments system. We study the role that the banking system plays in money stock determination and in the transmission of monetary policy. We then cover the motivation for borrowing and lending in credit markets, the two-country model of international finance, the cost of external finance, and the role of banks as financial intermediaries. We discuss banking and financial market distress with reference to recent events. Finally, we distinguish between banking and monetary policies, and assess the power of such policies, including "last resort lending," to act against financial fragility.
Prerequisites: 73150 and 73200

73-469 Global Electronic Markets: Economics and the Internet
Fall: 9 units

Fall or Spring The information revolution brought about by the Internet is having a dramatic impact on the organization of economic activity. Long-term contractual relationships that once governed corporate procurement are being dismantled as manufacturers use the Internet to market directly to the public. New transportation networks that used to simply move goods from point A to point B are evolving into dynamic inventory pipelines that allow manufacturers to track and even reroute shipments in real time. At the same time, individuals are making use of sophisticated search engines to comparison shop at a scale that would have been physically exhausting even five years ago. In the Economics of E-commerce, we will use the basic tools of economic analysis to understand how and why the changes in information technology are reshaping the economic landscape. (Lecture, 3 hours)
Prerequisites: 73251 or 73252

73-474 The Economics of Ideas: Growth, Innovation and Intellectual Property
9 units

Fall or Spring Healthy economies in many way resemble healthy people – they are alive and vibrant, growing and adjusting in response to changing circumstances – and what fuels economic growth and innovation are ideas. This course explores the role of ideas in the modern economy. Topics include: models of economic growth, economic efficiency and development, innovation and human capital, intellectual property and public policy issues. (Lecture, 3 hours)
Prerequisites: 73150 or 73251

73-476 American Economic History
Intermittent: 9 units

The study of economic history provides important perspective on current economic institutions and policies. A failure to understand the historical evolution of economic institutions or the variety of past economic experience is perhaps the worst shortcoming of many economists. The study of economic history provides an opportunity to test currently fashionable theories against data different from those used in their construction. In fact, this is a course in applied economics. The theories developed in the intermediate courses will be applied to episodes from the past in ways that increase understanding both of the specific historical episodes considered and the economic theories employed. (Lecture, 3 hours)
Prerequisites: 73150 and 73200 and (70208 or 73226)

73-495 Advanced Independent Study in Economics
All Semesters: 1-18 units

The Independent Study course in economics allows the student to pursue his or her own research interests in any of a variety of topics in economics. A typical independent study course involves a semester long project under the supervision of an appropriate faculty advisor. The nature and scope of the project are determined by the student and faculty advisor.
Prerequisites: 73251 or 73252

73-497 Senior Project
Fall: 9 units

A fourth-year project course, open only to Economics primary and additional majors with Senior standing.
Prerequisites: 73200 and 73226 and (73251 or 73252)

73-500 Tepper College Honors Thesis I
Fall and Spring: 3-18 units

Economics majors with outstanding academic records and intellectual promise will be given the opportunity to undertake original research under the direction of individual faculty members.

Research topics are selected by students and approved by faculty.
Prerequisites: Senior standing in the Economics Program and permission of the Economics faculty.

73-501 Tepper College Honors Thesis II
Fall and Spring: 3-18 units

Economics majors with outstanding academic records and intellectual promise will be given the opportunity to undertake original research under the direction of individual faculty members. Research topics are selected by students and approved by faculty.
Prerequisites: Senior standing in the Economics Program and permission of the Economics faculty.

English

76-100 Reading and Writing for an Academic Context
All Semesters: 9 units

76-100 is a reading and writing course for those students who are not native speakers of English. Students who have identified themselves as those who speak English as a second or third language rather than as their primary or home language are eligible to take this class. The course, designed as a prerequisite for 76-101, stresses reading in English for comprehension and application of key concepts for writing summaries and short position papers. Students will be introduced to readers' expectations for western rhetorical style at the sentence, paragraph, and whole text levels. Norms for academic English will be explicitly taught within the contexts of these assignments, as well as academic standards for citing sources. Students who take this course will qualify through a placement test that is administered through the university prior to the fall semester.

76-101 Interpretation and Argument
All Semesters: 9 units

76-101, a research-based First-Year English course, is structured to introduce students to an inductive process for writing an argument from sources. The course assumes that reading and writing are inseparable practices for responsible, academic authoring. In the course, students are exposed to a variety of different texts, both fiction and nonfiction, so that they can explore and critically evaluate a single issue from multiple perspectives. They are taught to summarize and analyze arguments within that issue so that they may contribute an argument of their own. The course is also geared toward helping students understand the requirements of college-level writing. Students should learn to be reflective and strategic with their composing processes as they plan, write, and revise their own texts. Ultimately, the course provides opportunities for students to develop critical thinking skills and strategic methods for analyzing and producing texts within the context of an academic community. Please see the English Department for detailed descriptions by section.

76-144 English Freshman Seminar
Intermittent: 9 units

Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. EXAMPLE: Fall 2008 This course is designed to consider art as an investigation of the self and the world. In a 2005 presidential address to the Society of American Archivists, Randall C. Jimerson reminded his colleagues, "archives are not neutral or objective." Jimerson's concerns regarding these repositories of collective memory echoed previous undertakings of archivists, historians, and writers as varied as George Orwell and George Lucas. In this course we will examine the inherent power dynamics of the collection process while engaging in the art of writing. Through a series of rigorous creative writing exercises in poetry and prose, we will mine newspapers, used bookstores, online audio exhibits, and personal artifacts to draft several new works. Students will compose weekly annotations or responses to texts, and will submit a creative project at the end of the course. No previous creative writing experience is required.

76-145 Freshman Seminar
Intermittent: 9 units

Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. EXAMPLE: Fall 2008 Taught collaboratively by professors in Economics and Literary Studies, this course takes a long historical view, from two different disciplinary perspectives, of labor markets and how poverty is defined, from the early years of English capitalism up to the present global economy. Students will learn how economists think about wage labor and poverty, as well as learning some of the cultural history of labor and its evil twin, poverty. They will learn how to analyze and interpret complex literary texts, how to analyze and compare different economic theories of labor and poverty, and how to understand both literature and theory in their historical and cultural contexts.

76-206 Introduction to Creative Writing

Fall and Spring: 9 units

This is not a workshop, but an introduction to the craft of creative writing. The class will read individual collections of poetry and fiction by contemporary authors in addition to a variety of essays written by poets and writers on the craft. A small percentage of class time will be spent on the critique of student poems, and original student writing and critical papers will represent much of the grade. Attendance and participation in class and at public readings are expected.

76-221 Studies in Classical Literature: Books You Should Have Read By Now

Intermittent: 9 units

It may seem more and more difficult to get a good classical, liberal education these days. The demands of professional training force many of us to skimp on our understanding of major artistic achievements. So, this class is for those people who should have read some of the best books around, but haven't managed to yet—books you should have read by now. Kurt Vonnegut's character Kilgore Trout sings the praises of Dostoevski's *The Brothers Karamazov*, (and the same thing might be said about *Crime and Punishment*) pointing out that it contains everything you need to know about life. He then ruefully adds that unfortunately that's not enough any more. It may not be enough, but it might be a place to start. Each book will be considered in itself for whatever it might offer by way of understanding the world, then and now. Finally we shall use the idea that literature is equipment for living as a way of understanding and evaluating our experiences. A recurrent interest will be in improving our language ability in general. Possible texts: *The Odyssey*, *Njal's Saga*, *Gulliver's Travels*, *The Brothers Karamazov*.

Prerequisites:

76-227 Comedy

Intermittent: 9 units

We can't, of course, expect to come up with an absolutely complete definition of the comic, but for our purposes we can consider it as an embodiment of the opposite of "gravity." Comedy is characterized by its levity. This does not mean, of course, that it is any less "serious" than tragedy, even if—or especially—because it tends to favor the superficial over the profound. Indeed, if tragedy is adolescent, then the mature, adult mode is the comic, being more social and rational. A key characteristic of comedy is wit—or simply intelligence. Comedy involves a lot of pure play of the mind. It turns out that there have been a few notable attempts to help us understand just why comedy is the "social" genre beyond all others, why the comic attitude is the civilized, urbane, mature view of life. And we'll consider some of those theories while trying to understand why some things are comic and some are not. We'll consider several classical works of comic literature, beginning with Aristophanes, Shakespeare, and moving on to more recent examples, including some films.

76-238 Introduction to Media Studies

Intermittent: 9 units

Karl Marx famously wrote, "The forming of the five senses is a labor of the entire history of the world down to the present." This introductory course will attempt to delve deeper into that which progressively fills the space between our senses and the world—mass media. Beginning with the telephone, film, music, television, through to the internet, this course will contextualize these media within two competing perspectives: mass media as cultural text and mass media as communicative technology. With a frequent return to the historical contexts of these media forms, students will develop their skills at reading and decoding these forms and offer their analyses through papers and weekly media observation journals. We will explore questions of authorship, reception (be it around gender, race, class and sexuality), cultural context, and the questions posed by increasing globalization. Readings will include selections from John Storey's *Cultural Theory and Popular Culture*, Paul Virilio's *War & Cinema*, and John Berger's *Ways of Seeing*, as well as several shorter pieces.

76-239 Introduction to Film Studies

Intermittent: 9 units

This course is an introduction to the technology, history, semiotics, and ideology of film. Its focus will be the Hollywood film, with special concentration on the "studio era" of that form, 1920-1950. The course will be organized more or less historically, beginning with early films by Méliès, Porter, and the brothers Lumière, moving through the development of different cinematic styles in European and American silent features, and then into the sound era. The course will conclude with the rise of the summer "blockbuster" as the closing of the studio era. In addition, we will note the

contributions of marginal modes to filmmaking as in documentary, and newsreel production.

Prerequisites: 76101

76-241 Introduction to Gender Studies

Intermittent: 9 units

This course will provide a general introduction to the central terms and debates of gender studies. We will begin with a close reading of John Stuart Mill's 'The Subjection of Women' as an introduction to liberal feminism, and then will follow with an extended readings from Simone De Beauvoir's 'The Second Sex,' which will provide an introduction to second-wave feminism, and more complex gender theory. The final third of the course will include a variety of readings in masculinity studies, queer theory, post-colonial gender theory, psychoanalytic thought, and other postmodern gender theory traditions. The course should involve lively conversation throughout, as well as watching a few films and television shows. Student grades will be based on essay exams, classroom discussion, and the completion of a final project in which students will appraise a cultural object (e.g. a novel, a show, a film, architecture, etc.) in regards to its gender portrayals and assumptions.

76-244 World English

Intermittent: 9 units

A Limit of 15 students from Pittsburgh. We welcome international students on the Pittsburgh campus to take this course. This course is primarily geared for sophomores. This course will study how so-called Standard English is broadening its definition to accommodate the fact that English is now an international language, the default lingua franca for all educated speakers and writers who share no other language. We shall study the social, economic, and political facts that have caused English to rise to this status. We shall also focus on many cultural issues raised by these facts. Each week will introduce readings raising new issues and students will be expected to write short weekly position papers relative to these issues. The course will have an international component, as it will be taken concurrently by CMU students on the Qatar campus, most of whom are not native speakers of English. We will have regular video "town meetings" between students on both campuses.

76-245 Shakespeare: Histories and Tragedies

Spring: 9 units

We will be reading eight plays—three histories from early in Shakespeare's career and five tragedies from later—and considering films of some of them. The course will approach these plays from two angles. First, we will try to see them in relation to the culture for which they were written and which they helped shape--the newly established public theater in London, prevailing notions about social class and gender, Puritan attacks on playgoing, and the like. In addition, we want to see these plays in terms of "what's in it for us"—how current audiences and readers can enjoy and interpret these plays. We will be considering what the plays have to say about the authoritative institutions and discourses of their time, and how they address us now that those institutions and discourses have been replaced by others. Students will be required to attend and participate regularly, submit brief responses in class from time to time, write three prepared essays, and take a final exam.

76-247 Shakespeare: Comedies and Romances

Fall: 9 units

Since the seventeenth century, publishers, directors and critics have divided Shakespeare's plays into specific genres or types. Plays ending in marriages, for example, are described as comedies, while plays that are filled with fantastic events are often called romances. In this class we will be reading a generous sampling of comedies and the late romances, asking how genre or generic expectations have shaped the composition and reception of these texts. We will also be asking how genres have served (and continue to serve) as the bearers of cultural memory and expressions of ideology, supplying a logic and pathos for the "order of things" which is alternatively dominant and subversive.

76-260 Survey of Forms: Fiction

Fall and Spring: 9 units

This is an introduction to the reading and writing of fiction designed as the first in a sequence of courses for creative writing majors and also as a general course for students wanting some experience in creative writing. Writing exercises will be devoted to such aspects of fiction as description, characterization, and narration, and to the writing of scenes and stories. In the second half of the course, students write a full short story of around 10-12 pages due two weeks before the end of the term. These are distributed to the class, discussed, and revised.

Prerequisites: 76101

76-261 Survey of Forms: Creative Nonfiction

All Semesters: 9 units

The National Endowment for the Arts defines "creative nonfiction" as "factual prose that is also literary." In this survey course, students will read a wide range of work that falls into this lively genre, including memoir, travel writing, the personal essay, and nature writing. Weekly writing assignments will give students the chance to work on short pieces of their own creative nonfiction.

Prerequisites: 76101

76-265 Survey of Forms: Poetry

Fall and Spring: 9 units

This course is an introduction to the reading and writing of poetry. It is designed as the first in a sequence of courses for creative writing majors. Non-majors wishing experience in the writing of verse, both traditional and free, are welcome. Writing exercises are concerned with the elements of diction, scansion and metrics, as well as imagery. Some classes are devoted to workshop sessions in which poems written by members of the class are discussed. Students are required to submit a final project, which contains exercises and poems written and revised throughout the semester.

Prerequisites: 76101

76-269 Survey of Forms: Screenwriting

Intermittent: 9 units

It is not so difficult to learn the format or even to master the style of the screenplay — the challenge lies in writing image-driven stories with believable dialogue, vivid characters, and a coherent, well-structured plot. Writing assignments include exercises that prepare students to write a polished short script — the blueprint for a well-told screen story. Students will also write short papers on assigned viewings.

Prerequisites: 76101

76-270 Writing for the Professions

All Semesters: 9 units

Writing in the Professions is a writing course specifically designed for students in all majors other than English. The course is appropriate for students in all CMU colleges, has no writing prerequisites, and assumes that you may not have had much college-level writing instruction past your freshman year. The basic idea of the course is to give you experience in developing the writing skills you will be expected to have as you make the transition from student to professional. The course will cover resume writing, proposal writing, writing instructions, the difference between writing for general and specific audiences, and analysis of visual aids in various texts. The course requires that students work both independently and in groups.

Prerequisites: 76101

76-271 Introduction to Professional and Technical Writing

All Semesters: 9 units

Introduction to Professional and Technical Writing is designed specifically for declared majors in Professional or Technical Writing. The main work of the course is a series of six situation-based writing assignments spread over three broad and often overlapping areas - business/professional writing, media writing, and technical writing. Typical assignments include resumes, correspondence, reviews and evaluations, news coverage, feature articles, consumer/user instructions, proposals, and adaptations of specialized information for non-expert audiences. At least one of the assignments will be a group project. As a final project, you'll create a portfolio of polished writing samples that you can use in applying for internships and employment. The range of assignments in the course is designed to give you experience with a variety of writing situations that Professional writers frequently encounter. The assignments also reflect options for specialization that you may wish to pursue in future coursework and in your career as a professional writer. As you work through the assignments, you should learn both current conventions for the kinds of writing you'll be doing and a broadly applicable procedure for analyzing novel situations and adapting conventional forms (and creating new ones) to meet the unique demands of each new situation and task.

Prerequisites: 76101

76-272 Language in Design

Fall: 9 units

Language in design is a professional communications course for designers. During your career as a designer, you will be expected to produce written documents to supplement and accompany your design processes and solutions. In this course, you will learn the conventions associated with the types of writing that designers most often have to produce on the job, such as proposals, memos, and reports. Additionally, you will prepare a job packet (including a resume, a cover letter, and a portfolio) that you can use as you begin your job search. You will also refine your ability to talk about

your projects to both expert and non-expert audiences. Ultimately, this course aims to prepare you for the professional communications situations that you will encounter in your design career.

76-294 Interpretive Practices

Fall and Spring: 9 units

This course introduces and explores some widely used terms for understanding various kinds of texts, including poetry, fiction, and filmed narrative. We will read essays on terms like "ideology," "intention," "culture," "genre," "convention" and the like to look at Dickens's long novel *Our Mutual Friend*, which, like its first Victorian audiences, we will read in "parts," a few chapters a week. Then we will try out these tools on some traditional poems and novels as well as some recent films and television episodes. Attendance is required and students are expected to contribute to class discussions, sometimes with prepared responses to the course materials. Two papers and a final exam will be required.

Prerequisites: 76101

76-300 Professional Seminar

Fall: 3 units

This once-a week, 3-unit seminar is designed to give writing majors an overview of career options in professional and technical writing. Practicing professionals in a range of communications fields – corporate communications, information architecture, public relations, journalism, science writing, healthcare communications, writing for non-profits, and writing for the software industry, for example – come to campus to talk with students and answer questions. Speakers generally talk informally about what they do, how they got into their fields, how students can prepare to enter those fields, and related career options. At the end of each session there is generally time for students to ask questions and talk individually with speakers. The course is required for first semester MAPW students and open to all English undergraduate majors, who are encouraged to take it in their sophomore or junior years. Grading is based solely on attendance, and there are no tests or assignments. To view the fall 2007 list of speakers, go to http://english.cmu.edu/degrees/ma_pw/curriculum.html, scroll down to "Professional Seminar," and click on the link to "2007 Poster & Schedule."

76-301 Internship

Fall and Spring: 3-12 units

This course is designed to help you explore possible writing-related careers as you gain workplace experience and earn academic credit. You'll work on- or off-campus as an entry-level professional for 8-10 hours per week in a field of interest to you. You might, for example, intern with a local newspaper or magazine or radio or TV station, work for a publisher or political campaign, or do research and promotions for a non-profit agency associated with a cause you feel strongly about. Other possibilities include local hospitals, museums, theatre and other arts groups, software documentation firms and other groups needing technical writers and communications specialists, PR and ad agencies, law related sites, and just about any place you can think of that requires writing and communication skills. Most of your class time for the course will be completed through work at your internship site -- a minimum of 120 hours (8-10 per week) over the semester for 9 units of credit. As the academic component of the course, you'll keep a reflective journal, do some related research and short writing assignments, and meet periodically with the internship coordinator to discuss your internship and related professional issues. The first step is to contact the instructor to set up a time to talk about your interests and what opportunities are open to you. You should do this before registration week so we have time to make necessary arrangements.

76-318 Communicating in the Global Marketplace

Intermittent: 9 units

In the current international environment, some of the most rewarding employment opportunities are in multinational and international settings. But are we prepared for the challenge of communicating with professionals from all over the world? Even as more people around the globe learn English, specific cultural values, beliefs, and assumptions continue to influence the way in which they communicate. More often than not there is a whole different worldview behind a foreign accent. Globalization brings along several pressing questions: How does technical and professional communication avoid the potential for misunderstanding and conflict that comes with cultural difference? How do companies whose business philosophies have been shaped by certain values and beliefs reach a workforce and customers who subscribe to different worldviews? How can international communication be effectively planned, measured, improved? This course prepares you to address these questions by explaining the specific ways in which national culture influences professional and technical communication, the

impact of globalization on business environments, and the ways in which you can rely on general concepts and principles in order to communicate effectively in specific international settings and situations.

Prerequisites: 76270 or 76271 or 76272 or 76390

76-319 Environmental Rhetoric

Fall: 9 units

How people think and talk about the environment matters; it reveals what they value and shapes what they do. We will look at how competing discourses define man's relationship to the natural world, frame environmental problems, and argue for public action. As we compare the environmental rhetoric of naturalists, scientists, policy makers, and activists, we will trace an American history that has managed to combine mystical celebration with militant critique, and scientific research with public debate. Equally important, this course will prepare you to act as a rhetorical consultant, by studying how writers communicate the three major "Rs" of environmental rhetoric: man's Relationship with nature, the looming presence of Risk, and the need for a Response.

Prerequisites: 76101

76-330 Medieval Literature: Women's Lives/Men's Lives

Intermittent: 9 units

Topics will vary by semester. Consult the course descriptions provided by the department each semester for current offerings. EXAMPLE: Women's Lives/Men's Lives. Some contemporary critics argue that fictions about individual agency began with Shakespeare (the invention of the human, as Harold Bloom puts it); are they right? This course will consider records from as early as the 700s and as late as the 1400s. We will explore the distinctive ways medieval men and women represented themselves in texts, their sober thoughts and their flights of fancy, including well-known fictions like Beowulf, The Song of Roland, Inferno, various Arthurian tales, and writing by women. Students will also choose one twentieth-century fiction based on medieval materials to read and report on. Course requirements include regular attendance and participation in discussions, three brief papers and a final exam.

76-331 Renaissance Literary and Cultural Studies

Intermittent: 9 units

Topics will vary by semester. Consult the Course Descriptions provided by the Department each semester for current offerings. EXAMPLE: X-Files of the Seventeenth Century. Ghosts, monsters, prodigies, demons, and other strange phenomena: many of these so called "preternatural" occurrences were becoming the object of overlapping (and sometimes conflicting) forms of explanation during the seventeenth century. Whereas some of these phenomena could be explained philosophically - with reference to natural causes - others belonged to religious debate or seemed exclusively to exist in the imagination. Using a broad range of texts, we will examine the widespread interest in the preternatural in seventeenth century culture, exploring the political, religious, and ideological consequences of this fascination. Texts for the class will include images of natural "marvels" and "monstrosities," collections of "curiosities," plays by William Shakespeare and Ben Jonson, utopian fiction by Margaret Cavendish, selections from Edmund Spenser's Faerie Queene, seventeenth century crime pamphlets, philosophical texts by Francis Bacon, Robert Hooke's images from the microscope, readings in Renaissance and classical poetics, and various religious texts. Students can expect the reading for this class to be demanding but interesting. Several written assignments, a final exam, and conscientious participation in class discussion will be required.

76-332 African American Literature

Intermittent: 9 units

Topics will vary by semester. Consult the course descriptions provided by the department each semester for current offerings. EXAMPLE: Fall 2008 In this course we will read canonical and non-canonical authors, untraditional genres like the graphic novel and some works of literary criticism in order to explore the various styles, themes and politics that define African-American literature. The list of authors we will read includes: Zora Neale Hurston, Ralph Ellison, Toni Morrison, Aaron McGruder, Paul Beatty, Heru Ptah and Bertice Berry.

Prerequisites: 76101

76-335 20th Century Literary and Cultural Studies: Postmodern Am/Brit Fiction and Film

Intermittent: 9 units

Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. EXAMPLE Fall 2007: This course will provide a clear and lucid introduction to major postmodern American and British postmodernist. The key texts are Doctorow's Ragtime, Robert Coover's The Universal Baseball

Association, and Graham Swift's Waterland. The themes to be explored are the relationship between postmodern and modern novels in terms of themes, narrative techniques, and material culture. This will be accomplished via a select reading of short essays and interviews by these novelists and by contrasting them with at least one novel by the modernist Philip Roth. The novels will be grounded in their times by discussions of postmodern architecture in the United States and what that means in terms of an artistic involvement with the fast changing world of globalization. This will be supplemented by film screenings (and discussions) of movies like Monty Python and the Meaning of Life and The Matrix that will serve to highlight the radical questioning of grand theories that have been traditionally served to explain social and literary phenomena. This will enable us to see the socio-cultural context of plurality and diversity that underscores our contemporary life and thought.

Prerequisites: 76101

76-339 Advanced Studies in Film and Media

Intermittent: 9 units

This course will examine globalization in East Asia over the last fifty years as seen through the prism of film. The term "globalization" can be taken monolithically to refer to a process of encroachment and subversion of a native culture. As one of the most visible of cultural products, however, film clearly demonstrates that this is frequently not the case. There is a complex interplay between pressures to globalize and the traditional concerns and norms of societies. An examination of the discourse and rhetoric of filmed texts provides evidence of cultures struggling to maintain their identity, adapting new modes of expression to their own ends and (eventually) actively exporting their own cultural ideas through the medium of cinema. To illustrate this point, we will closely examine the cinematic output of Japan, China and Korea from the mid-1950's to the present day. At the conclusion of this course students will have a basic knowledge of film output in the selected regions over the last 50 years, be aware of the aesthetic traditions, stylistic tendencies and rhetoric of those films, and have an understanding of issues of globalization as reflected in East Asian film.

Prerequisites: 76239

76-347 American Literary and Cultural Studies: Contemporary Fiction

Intermittent: 9 units

Topics will vary by semester. Consult the course descriptions provided by the Department each semester for current offerings. EXAMPLE: Fall 2008 Contemporary Fiction. In an age of digital media, what is the state of American fiction? This course will look at recent American fiction, mostly the novel, roughly from 1980 to the present. This era is as yet undefined, so one purpose of the course and your research will be to lend it some definition. The twentieth century is usually defined as modernist and postmodernist; this course will investigate writers who came to the fore after postmodernism (writers like Thomas Pynchon and Donald Barthelme). We will read stories and novels by writers beginning with Raymond Carver and concluding with Junot Diaz.

Prerequisites: 76101

76-349 Lost Generation

Intermittent: 9 units

Before the Beat Generation there was the Lost Generation. Both moments of literary history have an important relevance for our time, and both produced many major literary works. The 20's, like the 50's and 60's were marked by the effects of World War. Gertrude Stein seems to have started the whole generation naming fad with her comment to Hemingway, You are the lost generation. Paul Fussell identifies the cultural effect of WWI as the production of 'irony' as the central quality of modern identity (some Beat writers make a similar claim for the effects of WWII). This class is neither a prequel nor a sequel to the Beat writers class; it is related in theme but focussed on different writers and texts. Students might consider taking this class as a point of entry to 'The Beat', or might consider this class as a follow-on to 'The Beat' in order to understand more fully some of the central literary and historical issues of our time. In both cases we focus on the intersection between cultural change and major war. The Lost Generation class might include, for example, work by Stein, Hemingway, W.B. Yeats, Ezra Pound, T.S. Eliot, the major War Poets, F.Scott Fitzgerald, Robert Graves, Vera Brittain, Evelyn Waugh.

76-355 Leadership, Dialogue, and Change

Intermittent: 9 units

Leadership is often associated with the exercise of institutional authority or individual power. However the tradition of leadership based on dialogue shows us a powerful counter-rhetoric—one which organizes people to work together on complex problems through problem-posing, pragmatic inquiry, and the inclusion of marginalized

perspectives. We will learn how this approach to leadership and change works in public voices of writers such as Emerson and Martin Luther King, in the community organizing of an Alinsky, in the cultural critiques of African-American and feminist scholars such as Cornel West or bell hooks, and—equally importantly—in the ways ordinary professionals include voices and integrate social values into effective workplace writing, and the ways students call forth change on campuses. This introduction to the rhetoric of making a difference shows how its roots in American philosophical pragmatism created a focus on outcomes, not just ideals, and translated commitments into strategic rhetorical practices. In this course you will develop your own skills in writing and leadership by working as a “rhetorical consultant” to a campus or community group you choose: learning how to investigate and define a shared problem, to develop a briefing book for deliberation, and to support inclusive decision making by documenting rival perspectives and options (see www.cmu.edu.thinktank). This portfolio project will also demonstrate your research skills and ability to support a problem-solving dialogue within an intercultural community or complex organization.

Prerequisites: 76101

76-357 Language, Power and the Law

Fall: 9 units

This course provides an introduction to legal discourse, its specialized forms of language and argument, and a working knowledge of the ways professional writers and ordinary citizens can successfully operate within that discourse. We will address the nature of legal language, modes of argument in legal discussion, and critical legal studies. Students will learn practical strategies for understanding, navigating and manipulating legal language, as well as the importance of defining terms and making meaning. A portion of the course will be dedicated to examining legal issues related to authorship including intellectual property, free speech, and “telling the truth” in a variety of written forums. Readings will include a variety of texts ranging from US Supreme Court opinions to essays to news coverage of current issues. Writing assignments will include both legally-oriented professional documents directed towards decision makers and discursive, reflective essays. The course is appropriate for Professional Writing majors, pre-law students, and all those interested in understanding and managing the role of language in documents and communication practices affected by legal issues.

Prerequisites: 76101

76-359 Planning and Testing Documents

Intermittent: 9 units

We often send the documents we produce out into the world, having worked hard on them and hoping that they achieve the purposes that we intend for them. In some situations, this suffices. In others, however, we may need more than hard work and hope—we may need to know that a document is working: Are thousands or even millions of people going to be using the document? Can they comprehend it? Can they follow its directions safely? Are they fearful or confident as they do so? In Planning & Testing Documents, you will study and practice methods for providing valid and reliable answers to these types of questions, both in the lab—before a document goes out the door—and in the field—after a document is in the world. Learning about the problems readers have using documents can be a rewarding experience for professional writers. And the reasons for doing so are several: Various studies have shown that reader feedback helps professional writers optimize the effectiveness of their documents, that professional writers themselves are unable to predict the problems readers experience, and that writers become more aware of their audiences and improve as writers when they are regularly confronted with reader feedback. Topics will include both basic issues that pertain to all empirical research methods—sampling, response rates, validity and reliability, the design of questionnaires, scales and surveys, the ethical issues involved in doing research with people—as well as methods specifically relevant to planning and testing documents, such as subject matter expert (SME) observation and interviews, think-aloud usability testing (you’ll learn more than the “crash course” basics that you learned in your introductory professional writing course), plus-minus testing method, designing comprehension tests, and other reader-focused evaluation methods. See dept. for full description.

Prerequisites: 76270 or 76271 or 76272

76-360 Literary Journalism Workshop

Fall: 9 units

While culture becomes increasingly obsessed with celebrities, contemporary literary journalism is writing that usually focuses on so-called “ordinary” people in various social contexts. The emphasis is to use the journalistic essay to reveal character rooted in and influenced by a particular time and place. Students will be required

to do a series of short essays, and one long essay, on subjects of their own choosing. These essays will almost always involve field research; one goal of the course will be to acquaint students with research techniques and methods. This is both a reading and writing intensive course, and will be run usually as a workshop. The class is designed for both the professional writing student and creative writing student.

Prerequisites: 76260 or 76265 or 76270 or 76271 or 76272 or 76472

76-362 Reading in Forms: Nonfiction

Intermittent: 9 units

In the mid-1960s, journalists began to borrow literary techniques from fiction as a way to tell factual stories. In this course, we will read the work of some of the writers of what was then called “new nonfiction,” among them Norman Mailer, Tom Wolfe, Truman Capote, and Joan Didion, as well as the later works inspired by these writers. Students will write response papers for each class and will also be expected to take part in a collaborative project and complete a long analytical paper.

76-363 Reading in Forms: Poetry

Intermittent: 9 units

This course will focus on reading and analyzing poetry, concentrating on the use of poetic techniques. Students in this course will be able to improve their own poetry writing skills through achieving a greater awareness of how various techniques are used by established poets. Readings and topics will vary by semester.

76-365 Beginning Poetry Workshop

Intermittent: 9 units

This course is an introduction to writing and thinking about poetry. You are expected to learn the principles and elements of poetry and utilize them in workshop discussions, written analysis, and the composition of your own poems.

Prerequisites: 76265

76-372 Introduction to Journalism

Fall: 9 units

In this introductory class, taught by an experienced journalist, students will learn the fundamental skills of reporting, writing, and copy-editing. We’ll start with the basics – conducting research and interviews, the importance of accuracy, striving for objectivity, and judging newsworthiness. Because the key to learning to write effectively is to practice the necessary skills, class emphasis – and much of your grade – will be based on seven writing assignments involving current events and covering various types of news writing. Through readings, assignments and class discussion, we’ll tackle questions like these: What makes a story newsworthy? How does a reporter decide which points to emphasize? What are effective techniques for a successful interview? How does a journalist turn pages of scribbled notes into a coherent news story? We’ll do a lot of writing, but we’ll also examine issues and trends affecting journalism today. We’ll cover at least two live events and hear from local professionals about working in print, broadcast and public relations. We’ll also look at how newer mediums – such as blogs, the internet, and cable news – shape and influence newspaper reporting. With an historic presidential election in November, the media’s role in informing the public has never been more critical. How well, or poorly, they do their jobs will also be part of the ongoing class discussion.

Prerequisites: 76101

76-373 Topics in Rhetoric: Argument

Fall and Spring: 9 units

This course is an introduction to the theory and practice of argument. The session begins with an overview of major theories of (and approaches to) argument, along with short assignments to critically assess their value and relevance to the types of argument about which you, the student, are encouraged to investigate. You will choose a type or genre of argument upon which to focus your research. The argument type can be academic, practical, professional, and so forth, so long as it is understandable using terms and concepts covered by the course. During the second part of the session we will refine our understanding of argument, and you will develop your own approach to argument analysis. The last third of the session will be devoted to producing an original argument of the type you are researching.

Prerequisites: 76101

76-375 Magazine Writing

Spring: 9 units

In this course we’ll be reading lots of great non-fiction, some of which has appeared in magazines during the past few years. We’ll look at how excellent non-fiction for magazines has to employ a strong narrative voice, and the techniques of story telling. Students

will be asked to research and write their own articles, based on a variety of assignments. The class will be conducted as a discussion, and demands participation from each class member.

Prerequisites: 76260 or 76270 or 76271 or 76272 or 76372

76-377 Rhetoric of Fiction

Intermittent: 9 units

Wayne Booth's book, *The Rhetoric of Fiction*, is one of the classic discussions of the ways in which fiction communicates, moves or motivates us. It is a commonplace to assume that literature has a message, but it is still not at all clear just how an imaginative representation of the world does, or can, communicate. Booth had particular difficulty understanding how fiction could communicate a felt sense of life and value when there was doubt about narrative authority, or the 'reliability' of the author. So, postmodern fiction (from Joyce on) caused him problems. In an attempt to develop a postmodern rhetoric of fiction we shall be looking at texts that deal directly with issues of persuasion, or texts that seem directly to address the reader. Of particular interest will be texts that indirectly implicate the reader, and achieve a kind of implicit rhetoric even when they apparently frustrate normal expectations of communicative language (e.g. the apparent fact that the reader is also a character in Calvino's 'novel' if on a winters' night...). We'll consider the kinds of problems (and solutions to those problems) caused by excessive irony, by 'showing' rather than 'telling' and by the 'absent author' in texts like *Madame Bovary*, *Notes From Underground*, *Portrait of the Artist as a Young Man*, etc.

Prerequisites: 76101

76-378 Literacy: Educational Theory and Community Practice

Intermittent: 9 units

This course is an introduction to the interdisciplinary study of literacy- its history, theory, and problems. These include the tensions between academic and workplace literacy and the power struggle between elite and community literacies. We investigate the competing theories of how people learn, not just to read and write, but to control new literate practices, to operate within multiple discourses, and to use literacy to speak and act for themselves. It is also an opportunity to turn your ideas into action in a hands-on, community literacy project. In the second half of the term, we focus on ways community literacy allows everyday people in urban schools and inner city neighborhoods to take literate action for themselves. Our partner is Start On Success (SOS), an innovative program that helps urban teenagers with hidden learning disabilities negotiate this challenge as they make the transition from school to work or college. We will mentor a group of 9th grade students (here on campus) as they work through *Decision Makers* (a computer-based Carnegie Mellon learning project on writing and decision making). As a mentor, you will help an SOS Scholar create a personal *Decision Maker's Journey* book and learn new strategies for writing, planning and decision making. You will develop your own skills in intercultural collaboration and inquiry. You can visit the Intercultural Inquiry website at <http://english.cmu.edu/research/inquiry/two.html> to see what other community literacy mentors learned in this collaborative inquiry with their teenage partners, and can preview *Decision Makers* at www.cmu.edu/thinktank.

Prerequisites: 76101

76-382 Multimedia Authoring I

Intermittent: 9 units

This course will provide an introduction to the technical skills needed for designing On-Line content and Interactive Multimedia. Current multimedia tools for use in creating web-based products will be taught alongside ample opportunity for practice. Students learn authoring tools and multimedia techniques while covering topics including nontext-based communication, integration of visuals, the animation of text and graphics, and digital video web-deployment. Principles of design will be discussed and stressed throughout the course. Group design processes and project management issues will also be addressed. This course makes extensive use of web-oriented applications such as Dreamweaver and Flash. Preference will be given to majors in the English department, Multimedia Production minors and IS Majors in the Design and Communication Track. For English majors (EBA, CW, PW, and TW) who are also in the Multimedia minor, 76-382 may NOT double count toward both the minor and their English degree requirements. PW students interested in learning web and on-line information design are strongly advised to take 76-487, *On-Line Information Design* as their primary course in web design and web design issues. 76-382 may be taken in addition to 76-487 but should not be seen as a substitute for 76-487. Technical Writing (TW) majors are required to take 76-487, *On-Line Information Design*, as one of their core requirements and may NOT use 76-382 as a substitute. TW majors may, however, use 76-382 to fulfill one of their Theory/Specialization courses.

76-383 Multimedia Authoring II

Intermittent: 9 units

The growth of broadband internet access, faster computers and a more tech savvy audience have allowed multimedia content creators to develop more entertaining and engaging user experiences through the use of video, audio and animation. The Multimedia Level 2 course will introduce students to some of the most common tools and techniques used for developing these rich multimedia applications today. Some of the techniques covered are: Object Oriented multimedia programming and development using Adobe Flash and Flash Actionsript; motion graphics and animation using After Effects and Adobe Flash; audio and video encoding tools and techniques; 2D graphics and design using Adobe Illustrator and Adobe Photoshop. Students will be able to build dynamic, engaging user experiences for display in multiple mediums (web, CD-Rom, kiosks, etc.) and gain an understanding of the tools used to create them.

Prerequisites: 15100 or 15111 or 15112 or 15125 or 15127

76-385 Introduction to Discourse Analysis

Fall: 9 units

"Discourse" is language: people talking or signing or writing. Discourse analysts ask and answer many kinds of questions about how and why people do the things they do with language. We study the structure of written texts — the semi-conscious rules people use to organize paragraphs, for example — as well as the unconscious rules that organize oral discourse such as spontaneous stories and arguments. We study how people show each other how to interpret what they say as foreground or background information, casual remark or solemn promise, more of the same or change of topic. We look at how grammar is influenced by what people need to do with language, and how discourse affects grammar over time. We ask how children and other language learners learn how to make things happen with talk and writing. We ask how people learn what language is for, from exchanging information to writing poetry to perpetuating systems of belief. We analyze the choices speakers and writers make that show how they see themselves and how they relate to others. (Choices about how to address other people, for example, both create and reflect relationships of power and solidarity.) We study how people define social processes like disease, aging, and disability as they talk about them, and how language is used to mirror and establish social relations in institutional settings like law courts and schools as well as in families and among friends. This course touches on a selection of these topics and gives students practice in paying close attention to the details of language. The course is meant for anyone whose life work is likely to involve critical and/or productive work with language: writers and other communication designers, critics who work with written or spoken texts, historians, actors, sociologists, and so on.

Prerequisites: 76270 or 76271 or 76372 or 76375 or 76472

76-386 Language & Culture

Intermittent: 9 units

In this course we will develop an analysis of language based on its social functions —how it lets us persuade, express, assert, narrate, and organize our society and ourselves. Likewise, since all language is couched in, and undergirded by cultural assumptions and exists within specific cultural contexts, through analyzing language, we are also analyzing "culture." In this sense, we begin from the position that language and culture are inseparable, that one cannot be studied without the other. This course will engage students with multiple concepts of linguistic practice to explore the connections between human language and human life through readings, film, presentations, and discussion. The course is divided into three sections: (1) language and politics; (2) language and conceptual categories; and (3) language and cultural identity. We will begin by revisiting Orwell's 1984 to explore language's role in defining, maintaining, and subverting relations of power in society. Then we will trace the arguments of Benjamin Lee Whorf and others to examine how conceptual categories may structure thought and experience. These first two sections provide some fundamental understandings of how members of particular groups share particular ways of using signs. In the third and final section, we will focus exclusively on the construction of cultural identities by studying Lila Abu-Lughod's ethnography about various aspects of Bedouin culture such as blood ties, veiling, and poetry. This section will also include other readings that shed light on how people use language and linguistic performance as a resource to position themselves as members of a particular group by enacting their 'own' identity and that of 'others.'

Prerequisites: 76101

76-387 Sociolinguistics

Intermittent: 9 units

This course provides an overview of the field of sociolinguistics, or the study of language in its social and cultural contexts. Among the questions posed in the course are these: How and why do speakers select among the range of linguistic varieties in their repertoire, standard and vernacular, regional-sounding or not, more writerly or more oral, gendered in one way or another, and so on? How can such variation be accounted for in a theory of language? What kind of "grammar" is involved in knowing how to participate in conversations, and how do conversational styles differ from group to group? What causes misunderstanding and what enables understanding in interaction among people who are different? What are the effects of multilingualism and language contact, for speakers and for languages? How and why do standard varieties of languages come to be, and how are they perpetuated? What are the relationships between language, society, and the individual speaker? There will be several written assignments in addition to regular reading assignments, as well as a mid-term exam and a final project.

76-389 Rhetorical Grammar

Spring: 9 units

The course is designed for those who will be professionally concerned with writing. It aims to provide a standard framework for identifying and authoritatively discussing the grammatical forms and constructions of Written English that they will be employing in their work. The course will involve some theoretical linguistic study as well as practice in the parsing of sentences, recognition of types of constituents in the sentence, and control of the standard grammatical terminology. The concern throughout is with an explicit understanding of principles of sentence structure, i.e., grammar, as the essential basis of good professional writing and as a prerequisite for informed leadership in professional writing settings. Class meetings are devoted to explanation, grammatical analysis, and exercises, requiring careful preparation. There will be two major examinations (midterm and final), and two tests, upon which grades will be assessed. Text: Paul Hopper, *A Semester of Grammar*. Available from the CMU Campus Bookstore.

76-390 Style

Fall and Spring: 9 units

Style is a term used to describe the manner of expression in written language. To achieve the mastery of style that will enable you to express yourself in a way that is fresh, original, and appropriate across audiences and situations, you need to be able to choose the right words, arrange them appropriately, and punctuate them in a way that controls pacing and emphasis. This course is intended to help you achieve those goals. Working together, we will learn specific principles of style and examine the effects of stylistic variations. We will (1) derive a common vocabulary for discussing writing, (2) examine the effect of particular stylistic devices on readers, and (3) become better editors of our own writing and the writing of others.

Prerequisites: 76101

76-391 Document Design

Fall: 12 units

Today, many professionals are responsible for the visual design of documents. This course provides students who have already learned the foundation of written communication with an opportunity to develop the ability to analyze and create visual-verbal synergy in printed documents. Students will be introduced to the basic concepts and vocabulary, as well as the practical issues of visual communication design through a series of hands-on projects in various rhetorical situations. Assigned readings will complement the projects in exploring document design from historical, theoretical, and technological perspectives. Class discussions and critiquing are an essential part of this course. Adobe Creative Studio (In Design, Photoshop, and Illustrator) will be taught in class, and used to create the assigned projects.

Prerequisites: 51261 or 51262 or 76270 or 76271 or 76272

76-394 Research in English

Fall: 9 units

Advising Note: 76-394 is offered in the fall only. EBA majors should take 76-394 in the fall of their junior year to prepare for EBA 400-level seminar courses, for which 76-394 is a prerequisite. This course offers training in gathering information systematically and building arguments based on that information. Students will hone their skills in choosing a topic, addressing it with the help of relevant research resources, reading and interpreting texts, doing critical commentary, or conducting interviews and surveys. Students will also learn how to situate their work in the context of scholarly conversation, by testing their hypotheses against alternatives and

presenting their research to audiences in the field of English studies. To ground the discussions, the course uses a thematic content: it looks at the experience of political exiles and refugees in the post-World War II era.

Prerequisites: 76294

76-395 Science Writing

Spring: 9 units

This course will teach students how to write clear, well-organized, compelling articles about science and health topics for lay readers. Students will get a chance to read examples of top-notch science writing, talk with professional science writers and interview researchers, but the primary emphasis will be on writing a series of articles -- and rewriting them after they've been edited. Students should expect to see their writing critiqued in class from time to time, in a process similar to what journalists routinely go through. The goal will be clarity and verve; the ethos will be mutual learning and enjoyment.

Prerequisites: 76270 or 76271 or 76272 or 76372 or 76375 or 76472

76-396 Writing, Advocacy, and Public Policy

Fall: 9 units

Al Gore's internationally acclaimed documentary, "An Inconvenient Truth," is one of the most persuasive arguments in recent memory aimed at changing public opinion and policy. If you've seen the film, you probably recall its cutting-edge graphics and compelling explanations of complex climate change phenomena. What you may not have noticed is the way the overall policy argument is structured and how Gore effectively uses the five elements of all good advocacy arguments: (1) problem definition, (2) barrier analysis, (3) solution profiling, (4) impact projection and quantification, and (5) "ask" formulation. These elements underpin advocacy arguments in a wide variety of genres ranging from proposals and grant writing to editorials, testimony before legislative bodies, classic muckraking documentaries, and reformist literary nonfiction. In "Writing, Advocacy, and Public Policy," we'll examine excellent contemporary examples of these various genres advocating change, with many of our in-class examples focusing on arguments to promote better planetary and human health. To advance your own writing skills, you'll pick a current policy issue of special interest to you, research the issue thoroughly, practice and master the five elements, and use them to create a series of documents including opinion pieces, advocacy-oriented arguments using compelling graphics, a press kit and press conference, and related documents. When you leave the class, you'll have a set of commercially valuable writing skills applicable to more complex future projects.

Prerequisites: 76270 or 76271 or 76272 or 76372 or 76373

76-397 Instructional Text Design

Intermittent: 9 units

This course focuses on the planning, writing, and evaluating of instruction of various kinds, especially instructional texts. It is particularly appropriate for professional and technical writers, but also a good option for anyone interested in fields that involve substantial instruction, such as teaching or employee training. In the first part of the course, we'll examine the recent history of instructional design and the major current theories. Then we'll take a step back and study the concepts of learning upon which these theories are based, with particular attention to their implications for how instruction is structured. You'll find that different learners (e.g., children, older adults) and goals (e.g., learning concepts and principles, learning to apply principles to solve novel problems, learning a procedure, learning to change one's behavior, etc.) require different types of instruction. In the second part of the course, we'll look in detail at models of how people learn from texts and what features (e.g., advanced organizers, examples, metaphors, illustrations, multimedia) enhance learning under what circumstances. We will study and analyze particular types of texts. Some possible examples include an introduction to the concept of gravity; a tutorial for computer software; a self-paced unit in French; adult educational materials in health care; a workshop on sexual harassment in the workplace; or a unit to train someone how to moderate a discussion. We will also look at various methods (concept mapping, think-aloud, comprehension tests, etc.) that are used to plan and evaluate instructional text. You will do a project, either individually or in a small group (2-3), in which you design, write and evaluate instruction.

Prerequisites: 76270 or 76271 or 76272

76-420 Process of Reading and Writing

Spring: 9 units

This course is an introduction to the constructive processes behind reading and writing. It asks: what are social and cognitive processes, what are the conscious and unconscious problem-

solving strategies we use to comprehend and interpret text, to construct and communicate our own meanings, and to project or discover our readers' responses? Good writers and designers don't just convey information, they work as problem solvers trying to persuade, educate, or motivate in diverse contexts where they must anticipate the meaning-making reader and the constructive, interpretive process of comprehension. Understanding (and user-testing for) what readers actually make of a text is critical in many situations, from creating a job application, to a public relations crisis response, an educational website, or a policy report urging change. In this course, you will learn to recognize the factors that affect communication and to use methods that track the constructive, inferential process of readers' comprehension. You will learn the why behind the what they do through an introduction to the research and theory on reading and writing as social and cognitive processes. You will see how the action of memory networks, cognitive schemas, and meta-knowledge shapes and is shaped by language and discourse as socially constructed mediating tools. In the second half of the course we turn to your own writing as a thinking process in which you juggle competing goals and draw on problem-solving strategies for reader-based writing and design. The course project (which you can design as a portfolio piece focused on a kind of writing of your choice) will let you create a writer's toolkit of strategies 1) for effective composing & communication and 2) for comprehension-based inquiry and user testing, with real readers, to uncover how other people actually interpret what you thought you said. Prerequisites: 76101

76-431 Advanced Seminar in British Literary and Cultural Studies
Intermittent: 9 units

Topics will vary by semester. Consult the course descriptions offered by the department for current offerings. EXAMPLE Fall 2007: Prose Works of the English Renaissance EBA Majors: 76-294 and 76-394 are pre-requisites for this and all 400-level EBA seminars. In this seminar we will be examining a number of landmark prose texts (some in translation) that helped define the cultural and intellectual sensibilities of the English Renaissance. We will begin with an introduction to rhetoric and rhetorical practices in the period, moving on to discuss some possible genres that are emerging (or are undergoing changes) during the period: the Utopian fiction, the travelogue, the experimental report, the political pamphlet, the sensational news story, and the essay. Students will encounter works by Erasmus, Montaigne, Lyly, Swetnam, Speght, Hakluyt, Bacon, Nashe, Donne, Milton, and Behn. We will also be reading contemporary theorists and historians who explore ways in which the written word could simulate or order experience (retroactively, proactively) in ways that were deemed intrinsically productive. Prerequisites: 76294 Corequisites: 76-394

76-432 Advanced Seminar in African American Studies: Modernism and the Harlem Renaissance
Intermittent: 9 units

Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. EXAMPLE Fall 2006: Modernism and the Harlem Renaissance. This advanced seminar takes a broad, interdisciplinary approach to studying Harlem Renaissance culture and its significance. The Harlem Renaissance roughly encompasses a period in America between the two World Wars. Mass migration of African Americans to urban areas north and south, the experience of fighting for the U.S. overseas, a developing global consciousness, and improved education constituted some of the conditions of modernity that changed the composition, structure, and mindset of Black America. Black cultural production during this period articulated a form of American modernism, encouraged black political and social consciousness (and thus changed the face of urban and national politics), and spurred lasting debates about the relationship between culture and identity. It is well known that an explosion of literary production characterized African American culture during this period. Less well known are the roles performance, music, art and public debate played in ushering in new conceptions of community and race. Course materials include written work by Nella Larsen, Alain Locke, Zora Hurston, and Langston Hughes, including works that remain controversial, like Carl Van Vechten's *Nigger Heaven*. We will also examine artwork, music, and film and theatrical production. This class will approach questions of race, migration, creative expression, transnationalism, community, and identity. Prerequisites: 76294 Corequisites: 76-394

76-435 Feminist Cultural Studies
Intermittent: 9 units

What is feminist cultural studies? This course will answer this question with practical work as well as abstract definitions, with case studies as well as theory. The goal of the course is to develop some models for how to do feminist cultural study; we will pursue

this development through an instructor-designed model case study and through the design and study of cases that arise from the students' interests and intellectual investments: I. Model Case Study: We will work together on studying print materials that comprise a particular "case" from early modern English culture: In 1753 Elizabeth Canning, an 18-year-old servant, disappeared from her London home for nearly two months. She reappeared, nearly naked and in an emaciated condition, and told of being kidnapped and held captive in a "wicked" house where a gypsy named Mary Squires attempted to force her into prostitution. When, Canning claimed, she refused, she was held captive in an attic, with very little bread and water, until she managed to escape and walk the ten miles to her mother's house. II. Student Projects: Students in the class will design and develop their own projects in feminist cultural studies that will further help us to delineate and understand the methods and objects of study that comprise this critical, political, and theoretical field. These projects may be collaborative or individual. Students will design a case study select materials representative of that case for class reading lead discussions of the case write a prospectus for a feminist research project based on the case materials.

76-438 Advanced Seminar in American Literary and Cultural Studies
Intermittent: 9 units

Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. EXAMPLE Airtime: Radio, Television and Culture in the 20th Century. In this advanced course we will examine the cultural history and interpretation of radio and television. How do we apply the fields of literary studies and cultural studies to these vast, almost infinite forms of media? These are still relatively new fields, and thus we will look at new research, and you will also be expected to conduct new research of your own. Our readings will include Lynn Spigel, *Welcome to the Dreamhouse: Popular Media and the Postwar Suburbs*, Paul Buhle, *Hide in Plain Sight*, Michele Hilmes, *Radio Voices*, Robert McChesney, *Telecommunications, Mass Media and Democracy*, and Curtin and Spigel, eds., *Revolution Wasn't Televised*. Prerequisites: 76238 and 76239 and 76294

76-439 Advanced Seminar in Film and Media Studies: John Sayles
Intermittent: 9 units

Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. EXAMPLE Fall 2008: John Sayles John Sayles is America's leading independent filmmaker, and one of the few makers of explicitly political fiction films. He is also a successful screenwriter for hire, and one of Hollywood's top script doctors, besides being a respected author of novels and short stories. In this course we will see most of his films, including such titles as *The Return of the Secaucus Seven*, *Matewan*, *The Brother from Another Planet*, and *Lone Star*. We will read some of his screenplays, and some of his fiction. We will also consider works of literature and cinema that have influenced him, and perhaps a few that he has influenced. Prerequisites: 76239

76-441 Chaucer
Intermittent: 9 units

Geoffrey Chaucer is sometimes thought of as the author of universal, timeless fictions containing "God's plenty" (in Dryden's famous phrase). This course, however, will stress the ways in which Chaucer's fictions are situated within specific, but complex and fluid, 14th-century political, social, and religious controversies. We will read *The Canterbury Tales* and *Troilus and Criseyde* in Middle English (which is not hard to learn, but fun to know), and look at other representations of medieval English culture as it saw itself and as we see it from a 21st-century vantage point. Regular attendance, participation in classroom discussion, and brief oral presentations from time to time are required. Each of you will be asked to take a special interest in one of the Canterbury pilgrims and try to see the unfolding saga from that character's point of view. Writing assignments include two brief papers and one longer one, but no final exam. Graduate students will meet for an extra hour a week to discuss additional readings. Prerequisites: 76101

76-451 Topics in Language Study
Intermittent: 9 units

Seminars focusing on topics in linguistics and discourse studies. Topics will vary by semester. Consult detailed course descriptions available from the Department each semester for details. May be repeated for credit. EXAMPLE: Fall 2007 History of the English Language History of the English Language is widely taught in English departments, and besides supplying an essential historical perspective on the language of the documents that we study,

offers a significant extra qualification for anyone planning an academic career in a Department of English. The topic is vast: the linguistic and social history of the English language from its earliest attestations until the global spread of English and the emergence of the spectrum of "Englishes" in the modern world. We will single out some of the critical periods of change and study them for their linguistic and socio-cultural significance. The periods studied will include: the Germanic background; Old English; Early and Late Middle English; Early Modern English; Present Day English. We will study short texts characteristic of their time. Class lectures, readings and, if possible, visiting speakers will fill in details of cultural and literary events of relevance to the periods. Required texts will include John Algeo's workbook *Problems in the Origins and Development of the English Language*. Class meetings will consist of lectures and discussion of readings. The course is open to all Master's degree students (MA in Rhetoric, MA in LCS, MAPW, MDes), all doctoral students (Ph.D. in Rhetoric, Ph.D. in LCS), and to undergraduate English majors with Senior status. Others by permission.

Prerequisites: 76101

76-457 Topics in Language Study: Historical Linguistics

Intermittent: 9 units

Seminars focusing on topics in linguistics and discourse studies. Topics will This is a seminar course focusing on a variety of special topics in Rhetoric that examine the relationships among thought, expression, and understanding within specific social and cultural situations. Topics will vary by semester. Consult detailed course descriptions available from the Department each semester for details. May be repeated for credit. Spring 2008: Methods for the study of change in language, including the comparative method, internal reconstruction, and typological reconstruction. Problems in distant linguistic relationships and the propagation of languages; language contact, language birth, language death. Prerequisite: an elementary knowledge of phonetics or phonology, such as a course in which a certain amount of phonetic transcription was practiced. Prerequisites: 76101

76-460 Beginning Fiction Workshop

Fall and Spring: 9 units

In this workshop students will read stories and novels, write critically about these works of art, and create their own short stories. Knowledge gained in Survey of Forms will be put to use as students deepen their understanding of what it means to write good fiction. Each student will produce 25 pages of fiction, two critical essays, and be expected to participate in an ongoing class discussion focused on both professional and student work. Prerequisites: 76260

76-461 Personal Essay

Intermittent: 9 units

Prerequisites: At least one Survey of Forms (Fiction or Poetry) in which a student received a grade of an A or B. This is an advanced writing course that has been specifically designed for the student who wishes to polish and practice the skills of prose writing while pursuing the intellectual challenge of this peculiar form, the personal essay. Professional writing majors were particularly considered as "clients" for this course. The form of the personal essay did not exist until Michel Montaigne "accidentally" invented it in the 16th Century. His speculative musings, observations of nature and, especially, himself came together to make a unique genre which engages any topic while the actual subject of any topic is the essayist. To try to explore one's mind on a particular question has become a favorite activity of writers ever since — all the way down to Erma Bombeck and Russell Baker. Essays by Montaigne will be read to see how he put his thoughts together; was it a casual endeavor or a self-conscious craft? For us, the second method. Then, we will turn to more contemporary practitioners to study and enjoy their variations on the model. Meanwhile, students will put their writing skills to the test of this seemingly informal, arbitrary form. Some students will, at first, find it difficult not to make a point, not "to stick to the subject." The object here is to engage the full range of the mind's capacity for speculation and observation, recall and realignment of opinions and information. And, the results of this self-inquiry expressed in disciplined, lively prose. Student essays will be workshopped in class. By the end of the course, a student is required to have a portfolio of a minimum of 35 pages of essays — of various lengths — and all are to be finished. Rewritings of workshopped essays will be called for. Prerequisites: 76260 or 76265

76-462 Advanced Fiction Workshop

Fall and Spring: 9 units

This workshop requires the writing of a series of short stories set within a specific context: such as a family, a place or a community;

or within a particular philosophical or political concept. Successful completion of work in a Beginning Fiction Workshop is mandatory for admittance to this class. A final portfolio of a minimum of 35 pages is required. Sherwood Anderson's "Winesburg Ohio" will be read as a model of this genre as well as an important document of American literature. One paper will also be required in addition to the fiction work.

Prerequisites: 76460 or 76461 or 76462

76-465 Advanced Poetry Workshop

Fall and Spring: 9 units

This workshop will primarily involve discussions of the poems produced by class members. Grades will be determined by the following: regular attendance and workshop participation; essays on the selected poems of various contemporary poets; a final poetry manuscript which includes a substantial number of revised poems. Prerequisites: 76265 and 76365

76-466 Narrative Theory

Intermittent: 9 units

Is narrative a genre, method, or concept? Over the past three decades, scholars in various fields in the humanities and social sciences have become interested in narrative as a multifaceted object of inquiry, recognizing its wide applicability and explanatory power. Broadly conceived, storytelling is deemed an important element in our understanding of different artifacts and phenomena, among them texts, individuals, patterns of behavior, time, or memory—to name only a few. Yet it is not always clear whether "narrative" has, or should have the same meaning for cultural theorists, literary critics, rhetoricians, philosophers, historians, anthropologists, and psychologists. How can we define and explain narrative constructions in the consistent, as well as flexible manner that would recommend it as a tool for interdisciplinary research, that is, as both a feature of discourse and a style of thinking, a resource for literary or rhetorical writing and for scientific accounts? We will address this question by presenting basic concepts and methods used in the analysis of stories, and then applying them to both literary and non-literary instances. The course is designed to have broad-based appeal for Literary and Cultural Studies and Rhetoric students. We will read and discuss some of the key seminal studies in narrative theory, focusing on the following questions and topics: How does narrative structure representation? What is the role of agents in defining the meaning and significance of stories? What frames of reference do narratives constitute? You will be introduced to a variety of narrative approaches and models, from Aristotle to very recent developments in cognitive science, but our emphasis will be on putting an informed scholarship to use, applying ideas and theories to specific projects.

76-469 Screenwriting Workshop

Intermittent: 9 units

Prerequisites: A student must receive an A or B in 76-269: Survey of Forms: Screenwriting in order to enroll in 76-469. A student who received a C in 76-269 may enroll in 76-469 only with the permission of the 76-469 professor. A student who received a D or R in 76-269 may not enroll in 76-469. In this screenwriting course we will go beyond the conventional three-act structure and explore more inventive approaches. The course will challenge writers to take creative risks with genre, tone, character, and structure. It will explore mainstream, personal, and experimental narrative forms, surveying both American and international films. In a field where novelty often equals commercial success, we will strive to create screenplays that are innovative and exceptional. We will also try to link scriptwriting to other forms of storytelling, and discusses issues including the three-act structure, working with and against genre, character identification, and the implications of screenplay form. Key issues, examples, and case studies demonstrate what works, what doesn't, and why. Exercises will encourage writers to explore new ways of viewing their work and to test the limits of their skills. Prerequisites: 76269

76-472 Advanced Journalism

Spring: 9 units

This continuation of a two-course sequence begun in the fall semester will emphasize further refinement and use of the skills introduced in 76-372. Students will be encouraged to and assisted in finding outlets to publish their assignments. Weekly sessions will focus on the history and evolution of journalism in the 20th century as a way of understanding contemporary practices and trends. In addition, classes will include presentations of student projects; discussion of practical problems in newsgathering; analysis of published stories; and visits by professional journalists. While it is recommended that students with little to no journalism experience take 76-372 before enrolling in this course, students with previous or current journalism experience are encouraged to contact the

instructor for permission to enroll. This course may be taken more than once for credit.

Prerequisites: 76360 or 76372 or 76375 or 76376 or 76472

76-476 Rhetoric of Science

Intermittent: 9 units

Theories of nature developed using scientific methods are often perceived as truths discovered by a purely logical process whose results command instant acceptance within and without the scientific community. In this course, we will take a more sophisticated view of science considering the importance of such elements as language, genre, audience, values, and visuals in the production and acceptance of scientific knowledge both within and outside of scientific disciplines. In the process of this investigation, we will be exploring questions such as: In what ways is science rhetorical? How does the institutional and social context in which science is done shape scientific knowledge? What is the difference between arguments made for scientists and arguments made for non-scientists? In what ways does language shape scientific debate and knowledge? What argumentative solutions can visuals supply in science and what argumentative problems? Throughout the course we will grapple with these questions, analyzing their scope and implications with the help of various theories from philosophy, sociology, history, and modern and classical rhetoric. Our efforts will be mainly devoted to understanding and explaining the scientific enterprise as an undertaking with specific norms of interaction within which knowledge is produced according to various norms, conventions, practices and within different contexts. Our rhetorical approach will focus attention on how scientists use language to represent the world, develop new ideas, and communicate their work among themselves and to the public. But we will also consider how the application of rhetoric to science might re-shape our view of rhetorical theory and criticism. (See English Department for full description.)

Prerequisites: 76101

76-479 Marketing, Public Relations, and Corporate Communications

Spring: 9 units

Effective marketing and communications are essential to the success of businesses, non-profit agencies, academic institutions, public interest groups, and other groups of people that have a shared purpose and identity to promote. This course explores marketing and communications in organizational settings, where professional communicators manage relationships with a wide variety of constituencies: customers, investors, news agencies, employees, local communities, and local, regional, and national government agencies. To succeed, communicators must be able to identify and articulate the communication needs of the organizations they represent, develop well-informed strategies for advancing organizational objectives, think and act quickly in high-pressure situations, and write clear and persuasive prose. In this course, you will develop the written and oral communication skills needed by a professional communicator in an organization. You will learn to identify and define a coherent, integrated strategy for all of an organization's communications and to devise and apply effective marketing and public-relations tactics for achieving business objectives. You will gain practice in writing op-ed essays, press releases, critiques of organizational communications, and marketing and communication plans. (Please see English Department for complete course description.)

Prerequisites: 70340 or 76270 or 76271 or 76272 or 76372

76-481 Writing for Multimedia

Fall: 12 units

When you listen to a talking head on screen while a graphic is displayed behind the speaker and a stream of running text provides additional information at the bottom of that screen, you are having a multimedia experience. As such, you are also having a multimodal experience because you are looking at static and animated images, hearing sound, and reading text simultaneously or in quick succession. Writers concerned with the multimodal interests of multimedia, enter a realm with unique opportunities and constraints concerning the content and collaborative design of text, images, motion, and sound. In this class, we will first explore those constraints and opportunities by combining relevant literature with in-class discussions. We will then analyze examples of multimedia in order to discover how well those particular examples function within the noted constraints and opportunities. Finally, the class will produce solutions to three communication problems of increasing difficulty. Each will be story boarded before being produced. The class will contain a lab element that will focus on developing competence with key aspects of Flash.

Prerequisites: (76270 or 76271 or 76272 or 76260 or 76269) and (76391 or 76382 or 76383 or 76487)

76-482 Comparative Rhetoric

Intermittent: 9 units

This course serves a two-fold purpose. It attempts (1) to address the theoretical and methodological issues in cross-/inter-cultural communication from a rhetorical point of view and (2) to examine critically the way comparative studies of different rhetorical traditions/systems are currently conducted. In particular, it is concerned with the rhetorical problems we encounter in trying to write, argue, and persuade across languages and cultures. And it aims to take a close look at the need for rhetoric to rethink its own identity, purpose, formation and agenda in an increasingly multicultural and globalized world.

76-485 New Public Sphere

Intermittent: 9 units

Public deliberation is at the heart of the rhetorical tradition. But is public dialogue really a live option in a media-saturated world of sound bites addressed to plural publics? Is the process of debate, deliberation, and decision (in which the best argument wins) really the ideal model? Or can people use public spaces to develop new, more inclusive positions? Could such a process occur in a "mestiza" or boundary-crossing public when diverse groups enter intercultural deliberation around racial, social, or economic issues? This course looks at diverse ways people use rhetoric to take literate social action within local publics. From the canonical debate around Habermas and the public sphere, we move to a feminist "rereading" of the Sophists, to contemporary studies of deliberation in workplaces, web forums, grassroots groups, new media, and community think tanks. To support your own inquiry into the meaning making process of a local public, you will learn methods for activity analysis and for tracing social/cognitive negotiation.

Prerequisites: 76373

76-487 Online Information Design

Fall: 9 units

Students taking On-Line Information Design must register for both 76-487 and 76-488. The only exception to this policy is for IS students who have already completed 76-382 or 67-272. Only students enrolled in 76-487 may take 76-488. Online information design focuses on the issues and practices surrounding user-centered design for on-line applications. In other words, our goals focus on helping users easily perform tasks that meet their stated goals in a web-based interface. We focus our attention on three core design issues: user studies: by studying the literature on users as well as analyzing interviews and observations of actual users, important features and content concerns emerge that can be incorporated into the finished deliverable; information architecture: by studying the literature on site architecture as well as considering how actual users interact with the architecture of a particular site, important features and content approaches emerge (including organization, navigational design, link labeling, form and search design, and visual design) that can be incorporated into the finished deliverable; synthesis and application: by synthesizing those two elements, and applying the lessons learned to a partial redesign of a selected site, you develop the knowledge needed (including methods of iterative design, and methods for evaluating and reporting on a design's usability) to succeed in the interdisciplinary world of information design. The course's primary focus will be on the design of text/image information typical of Web sites, though issues in on-line design for other modes, such as sound and animation, as well as Web 2.0 will be touched upon. A series of homework assignments ask students to analyze and report on user needs, information architecture, and to iteratively develop a Web site. The course includes exams and a final project.

Prerequisites: (76270 or 76271 or 76379) AND (76391 or 76382 or 51261 or 51262)

76-488 On-Line Information Design Lab

Fall: 3 units

Lab exercises for On-line Information Design include the following: basic HTML, images, tables, animation, image maps, interactive forms, Web interfaces to databases, and basic Javascripting. All students must do the lab exercises. The exercises are designed so that those students who already know particular topics (e.g., basic HTML) do not need to attend the lab session. Students who would like guided practice in doing the lab exercises must attend the lab session. Lab sessions take place in a computer cluster.

Prerequisites: (76270 or 76271 or 76379) and (76391 or 76382 or 76383)

76-491 Software Documentation

Spring: 9 units

This course introduces students to basic practices involved in software documentation for both internal and external audiences. You will learn to understand the purpose of and create documents

appropriate for internal audiences (such as Requirements Documents) and external audiences (user guide, online help, marketing collateral). By the end of the course, you will have a grasp of the standard vocabulary, practices, and methodology for creating software documentation alone and as part of a development team. You will better understand the relationship between the software, its objectives and tasks, and the most effective ways to instruct users. You will also gain experience in assembling and writing material used in software releases, including analysis and requirements specifications documents. The course requires a series of homework assignments, collaboration, and several smaller team projects. Assigned readings and documentation examples will enhance the projects in providing a bridge between design theory and usage. Students will also use and gain experience with current authoring tools. Subtopics include the fundamentals of software design, project and document management, single-sourcing, and responding to change.

76-492 Rhetoric of Public Policy in the 19th Century

Intermittent: 9 units

The social, political, and cultural forces of Communism/Socialism, women's rights, racial equality, and ethnic cleansing which shaped the twentieth century have roots in nineteenth century debates about the conditions of the working poor, sexual inequality, slavery, and eugenics. Before many of the tools of modern media such as television, film, and internet, these issues found expression in papers, magazines, novels, and live gatherings which created or facilitated the formation of publics within which these issues could be debated. The goal of this course will be to investigate the formations of publics around the issues of worker's rights, women's rights, slavery, and eugenics in the nineteenth century and explore the rhetorical dimensions of the debates encouraged by these issues. We will examine broad questions such as what constitutes a public? How are publics formed? How do media effect debates? And more specific inquires like do different publics adopt different strategies for making arguments? Are different issues amenable to different types of argumentation? By investigating these questions, our goal will be to develop a better understanding of the nineteenth century culture of public argument and the process of the formation of publics around these specific issues in England and the United States during this period.

76-494 Healthcare Communications

Fall: 9 units

Healthcare Communications is a writing-intensive course designed for students interested in how healthcare information is developed by researchers, healthcare providers and writers and communicated to patients and their families, the general public, and other experts. Throughout the course, we will explore where people find medical information, how they use and evaluate it, and what challenges writers face in supporting informed healthcare decisions while communicating ideas that can be complex, provocative and sometimes frightening. We will read and discuss published literature dealing with issues in health literacy, clinical research, and patient care. We will also learn the basics of reading, understanding, and interpreting the research literature and communicating research findings to non-experts. Early in the semester, you'll choose a medical area of interest that you will research using sources such as journals, articles, books and web sites, as well as direct contact with appropriate medical, healthcare, and/or research professionals. For your final project, you will write and design materials that will meet a specific need or gap you identify in existing information. The final project could be a magazine article, a website, patient education material such as brochures or training materials, or another vehicle that emphasizes accurate, informative and engaging writing. In addition, there will be several short writing assignments to build the research and writing skills needed to effectively communicate healthcare information. A background in health, medicine or science is not necessary for this course, but a willingness to learn about these areas is essential.

Prerequisites: 76270 or 76271 or 76272

76-511 Senior Project

Intermittent: 9 units

Seniors in all four majors within the English Department may, with faculty permission and sponsorship, design and complete an original, student-planned Senior Project. Creative Writing majors may work on a book-length manuscript in fiction or poetry. Students in all majors within the Department may also, with the permission of a faculty advisor who will supervise and sponsor the project, develop and complete senior projects that involve either traditional academic research or investigations of problems in professional or technical communication.

History

79-104 Introduction to World History

All Semesters: 9 units

What are the most important developments and dilemmas in the world today? What bearing do these issues and processes have on our current lives and future prospects? And how can an exploration of world history help us engage the opportunities and challenges presented by the current workings of the world? Beginning and ending in the present, we will explore these questions by examining how historians and other social scientists characterize the processes that have connected and divided people around the world since the early fifteenth century and the social struggles that have taken place over alternative ways of organizing these connections and divisions. The aim is to make it easier for you to identify and assess not only (a) major continuities and changes in the workings of the world since the fifteenth century but also (b) the workings of broad social processes and relations, whatever the period or groups of people that concern you, and (c) where you stand regarding the complexities of the contemporary world, your place within it, and the possibilities available for collectively shaping the direction of future change.

79-112 Race, Nationality, and Culture in American Society

Intermittent: 9 units

This course examines the interplay of race, ethnicity, and nationality in the development of the United States. We evaluate the comparative role of these factors as different groups interacted over time in American society. This course pays close attention to larger socioeconomic, demographic, and political processes that shaped the lives of all Americans.

79-113 Culture and Identity in American Society

Intermittent: 9 units

This small discussion course traces ideas about individualism in the U.S., from colonial times through the 20th century. We will focus on three main themes: 1) the relationship between work and identity; 2) changing definitions of success and failure; and 3) the historical origins of contemporary attitudes toward 1 & 2. In short, we will study the economics and emotions of the American dream: how class, race, gender, occupation, and ambition shape our identities. Readings include *The Autobiography of Benjamin Franklin*; studies by Alexis de Tocqueville and Max Weber; writings of Frederick Douglass, Ralph Waldo Emerson, Herman Melville, and Henry Thoreau; Kate Chopin's *The Awakening*; Andrew Carnegie's *Gospel of Wealth*, Arthur Miller's *The Death of a Salesman*, and other works. Grading is based upon a readings journal, three short essays and a longer final paper, and on participation in discussion.

79-153 Freshman Seminar: Religion and Violence

Intermittent: 9 units

Why has religion so often been associated with violence? How can groups divided by religion achieve tolerance and respect for one another? In this course we will approach such questions by studying three historical situations: the wars of religion in the 16th and 17th centuries, the Northern Ireland conflict, and the contemporary problem of Islamic militancy.

79-154 Freshman Seminar: Education & Society in Comparative Perspective

Intermittent: 9 units

This course will analyze the evolution of key educational patterns and cultural characteristics of the United States and Russia during the past century and a half, with particular concern for distinguishing between education and culture. Educational innovation and reform movements in both countries, and the impact of each country on the other, will receive special attention, including such specific topics as the ideas of John Dewey, the Dalton Plan of schooling, the Project Method, the Core Curriculum, and the impact of Sputnik on American science education. Distinctive cultural achievements of both countries will also be highlighted, especially through art and music. The course will include secondary readings, primary documents, museum visits, and films.

79-155 Freshman Seminar: Rethinking Race: The Shaping of the African American Experience

Intermittent: 9 units

This course examines major issues in the development of African American urban life, from slavery to recent times. Students will explore major works that have shaped the field of African American urban history; pinpoint the strengths and weaknesses of past scholarship; and develop their own theoretical and methodological approach to the subject. In addition to weekly discussions of assigned readings, students will write a 15-20 page paper based upon an assessment of available scholarship as well as an examination of primary sources in various published sources, microfilm, and archival collections at Carnegie Mellon and the University of Pittsburgh.

79-156 Freshman Seminar: History of Psychoactive Drug Use in America
Intermittent: 9 units

This course will examine the use of psychoactive drugs in American history from a cultural and historical perspective, focusing chiefly on alcohol, opiates, marijuana, tobacco, and cocaine. We will explore both cultural patterns of drug use and policies directed at perceived problems associated with such use. Attempts to control use of various drugs, through law and policy and through informal social controls, will be examined. Primary texts, including narratives by drug users and perceived problems as described by social reformers and policy makers, will also be read.

79-157 Freshman Seminar: Feast & Famine: Population & Family Systems in Past and Present
Intermittent: 9 units

This course gives students an interdisciplinary introduction to the study of human communities considered as populations, with customs and practices regarding the family, marriage, migration, and reproduction as well as patterns of mortality. We study the basics of T.R. Malthus's theory of population, and see whether and how his work sheds light on the history of the west over the long-term. We compare findings on western Europe with societies in other regions of the world in both past and present. Topics include patterns of family formation, gender relations as they affect the family, the relation between economic and demographic systems, the incidence of "demographic catastrophes" such as epidemics and famines (including the Irish famine of the 1840s), and how the west broke out of the constraints of older patterns during the "demographic transition."

79-158 Freshman Seminar: Slavery and Emancipation in the Americas
Intermittent: 9 units

The course is an introduction to comparative slavery and emancipation in New World societies. It examines the evolution of the African slave trade and involuntary labor and their impact on the development of North America, South America, and the Caribbean Islands. It explores the distinctiveness of the overall Atlantic system and differences among slave societies. Major themes of the course include: tensions between domination and resistance; cultural adaptation of bound people; women and families; free people of color; and the relationship between race, class, and gender in systems of forced labor. Students will engage a variety of texts, including first-hand testimonies of slaves, traders, and owners in Africa, Europe, and the Americas.

79-161 Freshman Seminar: Hyphenated-Americans & the Stories They Tell
Intermittent: 9 units

Robert Coles, author of *The Call of Stories*, says that we all have accumulated stories in our lives, that each of us has a history of such stories about our lives, and that no one's stories are quite like anyone else's. In this course we will read a series of fictional stories written by hyphenated-Americans and analyze their experience through their characters. We will identify the common issues raised across a number of authors and time periods, question why certain issues are raised and others are not, compare these fictional accounts to historians' representation of the immigrant and hyphenated-American experience, examine whether the issues identified have changed over time in fictional accounts, and compare and contrast different ethnic-American authors writing at roughly the same time. We will, through the eyes of fiction writers, try to capture the essence of what it's like to be a hyphenated-American.

79-162 Freshman Seminar: "Slavery" and "Freedom" in African History?
Intermittent: 9 units

Living in a society still struggling to come to grips with its own history of slavery, American scholars have often imposed words like "slavery" and "freedom" onto African contexts. But, such labels have the effect of masking dynamic social institutions in pre-colonial Africa. This course will turn this terminology on its head by delineating the relationship between "slavery" and "freedom," kinship, dependency, and marginality. It will look historically at institutions which are integral to African societies, such as patron-client relationships, marriage, and pawnship. It will interrogate the multiple ways that these institutions functioned before the period of the trans-Atlantic slave trade and the multiple ways that African communities transformed their institutions in response to it. Students will engage a variety of historiographical debates in secondary sources and first-hand testimonies of "slave's" primary sources.

79-165 Freshman Seminar: The Historian as Detective and Storyteller
Intermittent: 9 units

Most history courses engage students in what is essentially the consumption of other historians' work. The centerpiece of such histories is the presentation of a carefully selected and defined research problem or agenda, and a narrative of the historian's findings and conclusions, with an explanation of evidence and methods playing an important but subordinate role. This seminar seeks to reverse this order in certain key respects. It places at center stage the fundamental tasks and motivations that historians face at the outset of their research, and of the many issues of research and presentation that pose additional challenges and choices for them along the way.

79-169 Freshman Seminar: Stalin and the Great Terror
Intermittent: 9 units

This course will explore a period of Soviet history known as "the Great Terror." Using a variety of sources, including history, memoirs, film, and primary source documents, we will examine the key questions associated with this dark and painful period in the Soviet past. We will explore Stalin's personal role, the execution of oppositionists in the Communist Party, the "mass operations" or round ups of targeted groups, and the spread of terror throughout society. The course begins with the murder of Sergei M. Kirov, the head of the Leningrad Party organization, in 1934. The murder was used by Stalin and his supporters to eliminate important civil liberties and judicial rights. It ends in 1939, when Nikolai Yezhov, the head of the NKVD, was replaced and executed for his role in repressing innocent people. The course will deal with the sharp debates among historians over the causes, meaning, and impact of the terror at the same time it familiarizes students with its history.

79-198 Research Training
Fall and Spring: 9 units

This course is part of a set of 100-level courses offered by H&SS departments as independent studies for second-semester freshmen, and first- or second-semester sophomores, in the College. In general, these courses are designed to give students some real research experience through work on a faculty project or lab in ways that might stimulate and nurture subsequent interest in research participation. Faculty and students devise a personal and regularized meeting and task schedule. Each Research Training course is worth 9 units, which generally means a minimum for students of about 9 work-hours per week. Prerequisites/restrictions: For H&SS students only; minimum cumulative QPA of 3.0 (at the time of registration) required for approved entry; additional prerequisites (e.g., language proficiency) may arise out of the particular demands of the research project in question. By permission of the relevant professor and the Director of Undergraduate Studies.

79-200 Historical Evidence and Interpretation
Fall and Spring: 12 units

"Historical Evidence and Interpretation" is a course designed to acquaint history majors and other students how historians really work. This course considers how historians practice their craft in interpreting great events. The emphasis is on learning to supplement standard secondary accounts of an event with primary sources such as memoirs, government documents, speeches, interviews, newspapers, maps, eye-witnesses and UN resolutions. Other unusual sources include poetry, music, film, satire, and political cartoons. The goal is for the student to develop a familiarity with the skills an historian uses to identify a research topic, make use of a wide array of sources, and present his or her findings in a proper scholarly fashion.

79-201 Introduction to Anthropology
Fall and Spring: 9 units

Cultural anthropologists "make the strange familiar and the familiar strange," attempting to understand the internal logic of cultures which might, at first glance, seem bizarre to us, while at the same time probing those aspects of our own society which might appear equally bizarre to outsiders. In doing so, anthropology makes us more aware of our own culturally-ingrained assumptions, while broadening our understanding of the possibilities and alternatives in human experience. This course will use ethnographic writings (descriptive accounts of particular cultures), as well as ethnographic films, to investigate the ways in which diverse societies structure family life, resolve conflict, construct gender relations, organize subsistence, etc. We will assess the advantages and pitfalls of comparing cross-cultural data, analyze the workings of power within and between societies, and consider the politics of cultural representations. We will also discuss what the anthropologist's relationship is to the people s/he studies, and the responsibilities inherent in that relationship. Throughout the course, students will

learn the importance of an historical perspective on culture, looking at how and why societies change, and considering how we, as anthropologists, should assess these changes.

79-202 The History of Public Policy in the United States
Intermittent: 9 units

This course will describe and analyze aspects of the development of public policy in the United States from the colonial era to the present. For the purposes of this course, public policy will be defined as the making of rules and laws and their implementation by government either: 1) in response to the failure of private markets to reach desirable outcomes; or 2) in an attempt to achieve a particular normative vision of what the world/society ought to be like. This course assumes that the public policy landscape is complex but still comprehensible given the proper set of analytical frameworks and appropriate historical background. Particular emphasis will be placed on: changing views about the authority of the government to intervene in economic and social issues; the best way to balance individual and collective interests; and the variability within society of the life courses of individuals. Topics to be covered include: property rights, science and technology policy, environmental regulation, competition, civil rights, and drug policy.

79-204 20th Century America
Intermittent: 9 units

The twentieth century marked the rise of the United States as a global power. By the end of the century, the United States had achieved economic, military, and political dominance. The United States also made great strides in expanding political and civil rights for workers, women, African-Americans, and gays and lesbians. This course explores the cultural implications of these developments on the generations of American people who came of age in the twentieth century. It assesses both the triumphs and tribulations of twentieth-century life. We will analyze the continuities, contradictions, and conflicts in American history, especially in regard to the nation's twin pillars: democracy and capitalism. Special attention will be given to the evolving relationship among the state, the corporate sector, and ordinary people. Topics include: Progressivism, the Great Depression, World War II, the Cold War, Civil Rights, Vietnam, and the New Conservatism.

79-205 20th Century Europe
Intermittent: 9 units

This course covers aspects of western European history from 1914 to the 1990s. Its themes are the roots of the profound crisis of democracy and civil society and the parallel rise of radical intolerance in Europe between 1918 and 1945 and the causes behind the success of democratic republics since World War II. We consider the social and economic impact of the two World Wars, the extraordinary artistic vitality of the 1920s, and the reasons why some countries produced large and successful fascist movements while others did not. We also discuss the rise of Communist parties and the crisis of democratic socialism. In the post-war era we focus on European responses to revolts against colonialism, the "economic miracle" of the 1950s, anti-Communism, and student radicalism of the 1960s. Readings include primary sources, novels, reportage, and scholarly monographs.

79-206 Development of American Culture
Intermittent: 9 units

This is an introductory survey of American history from colonial times to the present. The course focuses on cultural analysis instead of the more traditional emphasis on presidents, wars, and memorizing facts or timelines. The major theme of the course is the changing meaning of freedom over three centuries. Required readings include novels, memoirs, historical documents, and a study of the concept of freedom. There is no textbook; background facts and events are covered in lectures to provide students with context needed to think about and understand America's cultural history. Assignments include exams and essays.

79-207 Development of European Culture
Intermittent: 9 units

This course surveys the evolution of European culture from 1500-1950. It defines 'culture' broadly to include not only philosophy, literature, and art but also science, manners, sexuality, morality, and religion. Lectures, readings, and discussions will introduce students to what Europeans thought and wrote about these questions. Readings will include no 'history books' but only novels, plays, and memoirs. We will discuss these writings, on the one hand, as 'literature', that is, as examples of literary styles and themes and, on the other hand, as documents that reveal much about the philosophical and social conflicts that divided Europeans.

79-208 Theory and Practice in History and Policy
Intermittent: 9 units

This course will use the most pressing policy issue in the United States today - the ongoing military intervention in Iraq - to explore theoretical models for linking historical inquiry to public policy making. We will begin by examining how policy makers and the media in the United States draw on history to assess the current situation. Then, we will do some general readings about theory of history and policy. What are the grounds for believing that we can "learn from the past?" The bulk of the course will be devoted to learning about two historical events: U.S. military interventions in Cuba in the early twentieth century; and the British occupation of Iraq. We will then consider what, if anything, can be learned from these examples about the dynamics of occupation that can inform current U.S. policies in Iraq. Students will be expected to do close readings of course material and participate actively in discussions. In addition to frequent short analytical writing assignments, each student will produce a final paper (10-12 pp.) that considers the potential and limitations for using historical comparisons to inform contemporary U.S. policy toward Iraq. Students will present their findings to one another and a small invited audience at the end of the semester. This is an introductory course in the History and Policy major. Declared majors will have priority enrolling in the course. Other students may enroll with the instructor's permission. Prerequisites: 79202 or 88202

79-209 Theory and Practice in Anthropology
Intermittent: 9 units

How has anthropology changed over its relatively short lifetime? This course will examine the major trends and schools of thought in anthropology in the twentieth century, focusing on how theory shapes the questions anthropologists ask as well as their fieldwork methods. Students will learn to "find" theory within ethnographic writing, both by analyzing the work of notable anthropologists, and by experimenting with various theoretical orientations in their own analysis of ethnographic data. After first examining some of the 19th century influences on the emerging field of social science, we will explore the paths anthropology took in the early and mid-twentieth century, focusing on how culture and social structure were understood and analyzed at this time. Next, we will turn to issues of power, practice, and history, and the influence of new theoretical approaches on anthropological conceptualizations of culture. Finally, we will explore how more recent theoretical trends, including feminist and post-modern contributions, have shaped contemporary anthropology. The course will emphasize that, though theory has developed in recognizable ways throughout anthropology's history, this development has not been linear. To show how older theoretical approaches resurface in more recent anthropological work, readings will pair classic works in the various theoretical schools with more contemporary reworkings of those same theoretical orientations.

79-211 Disaster! Hurricanes, Plagues, Fires, and Floods in American History
Intermittent: 9 units

Unlike technological catastrophes - like oil spills or nuclear meltdowns - people often see natural disasters as being caused by unavoidable acts of nature outside human control. This course questions that assumption by exploring the historical role of people in disastrous epidemics, fires, floods, and hurricanes in the United States. We will examine the material causes of so-called "natural disasters" and analyze how Americans have been affected differently according to their race, class, and sex. In addition to understanding the human experience, we will explore how popular culture has imagined natural disaster in the course of the History of the United States. By the end of the semester, we will have examined some of America's largest "natural disasters" in their historical contexts, and we will use this knowledge to think about the disasters that Americans face now and in the future.

79-212 Disastrous Encounters: Technology & the Environment in Global Historical Context
Intermittent: 9 units

Broadly conceived this course examines so-called natural disasters as key historical moments in the evolution of cultural and economic relationships in the world from the modern era through the late twentieth century. Specifically, it deals with the material causes of natural disasters within a framework of the development and adaptation of technology by various cultural and social groups. It emphasizes the ways people have shaped their environments and how they have assessed and responded to the risk of disaster based on those actions. Of equal importance is the role of systems for the exchange of information in predicting, preparing for, and responding to natural disasters. Readings, lectures, and classroom discussions (supplemented by the use of guest speakers) will focus on major natural disasters as comparative case studies aimed at giving

students an understanding of the connections between technology, global power relationships, and environmental change. Students will analyze how people have been affected differently according to their race, ethnicity, class, and sex and use this knowledge to think about continuing environmental change and the disasters faced by the global community now and in the future. As such, students will gain an appreciation for the variety of socioeconomic, political, and cultural factors that blur the line between natural and technological disasters.

79-214 18th Century European History

Intermittent: 9 units

The goal of this course will be to examine, in both breadth and depth, the history of Europe between roughly 1715 (the death of Louis XVI) and 1815 (the fall of Napoleon). Broad themes to be covered include "old regime" Europe, European religiosity and secularism, the Enlightenment, the development of public opinion, the rise of Prussia, the industrial revolution in Britain and the continent, mercantilism, and trends in the arts. Students will be expected to attend lectures, participate in class discussion, write two exams, read and discuss a number of primary and secondary sources, submit weekly opinion papers, and complete a term paper on an 18th-century European topic.

79-216 French History: From the Revolution to De Gaulle

Intermittent: 9 units

This course looks at French society and culture from the period after the French Revolution (roughly 1815) to the Second World War. Rather than trying to cover all events, we will focus on some of the lasting features of French society in the period. We profile the different social classes (workers, peasants, elites); examine France's revolutionary tradition and its religious conflicts as well as the multiple impacts of war. We do this through the use of fiction as well as film, art, and historians' writings about the period. *** This is a regular 9-unit course, but qualified French language students may add three units with the permission of the instructor, under the "language enrichment" option (79-490), by doing some reading and writing in French for course assignments.

79-218 The Roots of Rock & Roll

Intermittent: 9 units

This large-lecture course spans the century from 1870 to 1970 and spends 8 weeks on "roots" music – slave songs, Anglo-Appalachian ballads, ragtime, Tin Pan Alley, and 1920s-1930s blues and country – before you'll hear a single electric guitar. After studying Bessie Smith, Woody Guthrie, Lead Belly, Hank Williams, and other early artists, we'll spend the last 7 weeks on revolutionaries like Chuck Berry, Bob Dylan, Jimi Hendrix, and Janis Joplin. The format is informal lecture and discussion on Tues/Thurs afternoons, plus a required film screening every Tuesday evening, 6:30-9:20pm. Assignments include reading 2-3 books and many articles (including some cultural theory), weekly music listening, four short papers, occasional quizzes, and a final project.

79-219 The Holocaust in Historical Perspective

Intermittent: 9 units

This course explores the attitudes and actions of the Holocaust perpetrators, the bystanders, and the victims. Moreover, it discusses what implications and issues arise from this watershed event in World and Jewish history. It descends into the world of the Holocaust not only by reading about events and viewing several films, but also by meeting Holocaust survivors.

79-220 Early Christianity

Intermittent: 9 units

In this course we examine the origins of Christianity. Although we deal with biblical, as well as other contemporary, materials, the approach is not theological but historical. We want to understand how and why Christianity assumed the form that it did by examining its background in the Jewish community of Palestine, its place in the classical world, its relationship to other mystery religions of the time and certain variant forms (now known as Gnosticism) which it assumed prior to the crystallization of orthodoxy.

79-221 Christendom Divided: The Protestant and Catholic Reformations, 1450-1650

Intermittent: 9 units

At the dawn of the sixteenth century, western Europeans still shared a common religion and identity as members of the Roman Catholic Church. Within less than two decades, this uniformity began to crumble, and the very fabric of western culture was irrevocably altered. By 1550, Europe was splintered into various conflicting churches, confessions, sects, and factions, each with its own set of truths and its own plan for reforming the church and society at large. This period of rapid and unprecedented change in western history is commonly known as the Reformation. Though this term

has traditionally referred to the birth of Protestantism, it also encompasses the simultaneous renewal and reform that occurred within Roman Catholicism. This course will survey the Reformations of the sixteenth century, both Protestant and Catholic, examining the causes of the Reformation, the dynamics of reform, and its significance for western society and culture. In the process, we will analyze such on-going problems as religious persecution and the accommodation of dissent, the relationship between religion and politics, and the interactions between ideology and political, social, and economic factors in the process of historical change.

79-222 Religion in American Society

Intermittent: 9 units

Opinion polls taken from the 1940s through the 1990s report annually that over 90 percent of Americans believe in God. Our earliest institutions, when they were not churches themselves, reflected a strong religious influence. Americans have felt religious competition so keenly in various times in our history that they have rioted in support of one denomination over another. Why was (is) this so? How have Americans experienced, thought about, and manifested their various religious beliefs throughout our history, and how have Americans interacted with fellow citizens of differing beliefs? How has religion influenced the development of our current institutions, and why do Americans believe what they do? This course examines these and other issues connected to American religious development.

79-223 Protest and Dissent in American History

Intermittent: 9 units

What does it mean to protest in a country that was founded by revolutionaries? Are radicals heroes or traitors? Dissenters like Sarah Grimke, Frederick Douglass, Susan B. Anthony, Eugene V. Debs, Emma Goldman, Malcolm X, Cesar Chavez and others struggled for different convictions but had one thing in common: to further their causes they had to overcome the traditional aversion to radicalism in America. This course traces not only the history of particular protest movements since revolutionary times, but also the historical development of mainstream politics, law, and public opinion regarding radical dissent.

79-225 Religions of China

Intermittent: 9 units

How have Chinese addressed universal questions of personal meaning and survival, and of social connection and authority, with the help of religion? This course is interested in solutions elaborated over the centuries by Chinese of all social classes. Without neglecting the textual canon, we are particularly interested in changing styles of ritual organization and practice. We examine mutual borrowing and competition among shamanism, ancestor worship, Confucianism, Buddhism, and Daoism, and the adaptation of each to varying social contexts and state policies up to the present. Much of the material is in the form of original sources including descriptive accounts introduced by religious historians, and fiction. The last half of the course utilizes ethnography of Taiwan and Mainland China to account for the current flourishing of religion. It also considers whether Maoism is a sort of religion, and examines the fate of the Falungong in historical context.

79-226 History of German Cinema/History of Modern Germany through its Cinema

Intermittent: 9 units

This course offers both a history of German cinema and a survey of 20th-century Germany as seen through German films. As film history, the course introduces students to movies spanning the silent era, Nazi films, the West German New Wave, socialist cinema, and post-unification movies. We will consider stylistic and technical trends as well as dramatic content. As a course in German history, the course sets major movies from each era against a backdrop of political and social developments. We will also analyze the portrayal of World War II and the Third Reich in films made after 1945. We will view c. 20 films, most in class, several in the evening. Readings will include works on the history of German film and a textbook on 20th-century German history. Writing will consist of three 5-page essays and one 8-10 page paper

79-230 Technology in American Society

Intermittent: 9 units

This course introduces students to the history of technology in the United States and examines the ways that American society both shaped and was shaped by technological change. The course's readings, films, and lectures give voice to both the prophets of technological progress and those who found both such change and its prophets less than desirable. The course aims to raise fundamental questions about technology, society, culture, and power and their interaction across time and space.

79-231 American Foreign Policy 1945-Present

Fall and Spring: 9 units

This course provides an introduction to the study of U.S. foreign policy. Its main focus will be on problems and possibilities confronting the world during the Cold War as well as global political changes in the post-Cold War era and since 9/11. Important foreign policy strategies which will be discussed include the strategy of containment, NSC-68, the Eisenhower-Dulles "New Look," the Kennedy-Johnson "flexible response," "détente," the democratic peace, and contemporary approaches to combating global terror. Theoretical readings in history and political science will be used as analytic filters to assess both scholarly evaluations of American foreign policy and key historical episodes.

79-233 The United States and the Middle East since 1945

Intermittent: 9 units

Since the end of WWII, the United States has been increasingly involved in Middle Eastern affairs. This course examines US interests and intrigues in the region, moving chronologically from 1945 to the present by way of multiple case studies concerning US relations with key Middle East actors. Issues covered include the Cold War in the Middle East arena; oil politics; US as Arab-Israeli peacemaker; US military intervention; Islamic fundamentalism; and US interests in the Persian Gulf.

79-234 Body Politics: Women and Health in America

Intermittent: 9 units

Women's bodies have been the sites of long-standing, and sometimes deadly, political battles. This course takes a topical approach to the history of American women's health in the nineteenth and twentieth centuries in order to understand why women's bodies have been such heated sites of struggle. It covers topics such as the history of contraception, abortion, menstruation, sexuality, female anatomy, rape, domestic abuse, menopause, pregnancy, and childbirth. It explores how American culture has constructed these issues over time, while also examining women's organizing around them.

79-236 Eighteenth Century China Through Literature

Intermittent: 9 units

Run like a seminar, this course examines China's most famous novel, the 18th century work by Cao Xueqin and Gao E, *The Story of the Stone* (aka *Dream of Red Mansions*, *Hongloumeng*), in a lively five-volume translation. This portrait of a family in decline offers a comprehensive view of urban social life and culture in the 18th century. We add brief analytical readings on such key topics as authority in the family, gender, sexuality, folk religion, connoisseurship (of food, gardens, art, poetry), patronage and ethnic relations. In case some of the volumes go out of print, the seminar will read a one-volume version and parts of several other novels of the period. No prior knowledge of China is required, but you should enjoy reading! Limited enrollment, assigned papers, no exams.

79-237 City Histories: Delhi and London

Intermittent: 9 units

The British Empire connected two great cities – London and Delhi – but even before the British came to India, Tudor London and Mughal Delhi presented a dazzling display of imperial politics and culture to the world. This course looks at the parallel destinies of these metropolises. It proceeds from that early-modern period into the age of Queen Victoria and her Indian Viceroy, down until today's post-colonial era. Finally, it examines some of the ways in which late-modern political events, environmental change and migration have affected these two civic spaces. Art, travel, diaries, poetry, film, music and other documents will supplement the main textbooks. At the end of the course, you are expected to have learnt something about South Asian and British history, about city cultures in 'East' and 'West' and to have reflected about the changing roles for metropolises in a contemporary globalized world.

79-240 Recent U.S. History 1945 - Present

Intermittent: 9 units

This course will explore the social and cultural history of America since World War II. Topics include: the dawn of the nuclear age, the cold war, the beatniks, the Korean and Vietnam wars, the civil rights movement, the women's movement, hippies, the energy crisis of the 1970s, the rise of environmentalism, yuppies, the turn toward conservatism in the 1980s. We will use music, film, television, and literature as evidence of cultural change in American society during the past 50 years.

79-241 African-American History I

Intermittent: 9 units

This course examines a series of topics--economic, demographic, social, cultural and political--in African-American history from

slavery to the Civil War. The evolution of race relations is an important component of the course, but the major emphasis is placed on the internal experiences of black people within the framework of larger socioeconomic and political processes in U.S. history. Although the course includes a general text, assigned readings revolve around detailed studies of particular topics (e.g., work, family, and religion) or chronological periods (e.g., the colonial, revolutionary, and ante-bellum eras).

79-242 African-American History II

Intermittent: 9 units

This course examines the black experience from Reconstruction to the present. The evolution of race relations is an important component of the course, but the major emphasis is placed on the internal experiences of black people, within the framework of larger socioeconomic and political processes in U.S. history. Although the course includes a general text, assigned readings revolve around detailed studies of particular topics (e.g., work, family, and religion) or chronological periods (e.g., the Great Migration, Depression, World War II, and the Civil Rights Era).

79-243 A History of American Urban Life

Intermittent: 9 units

This course examines the development of urban America during the 19th and 20th centuries. It explores the evolution of urban structure; the development and impact of urban technologies (transportation, water/wastewater, energy and communications); ethnic and racial change and class conflict in the city; and political and policy issues. It discusses alterations in American city structure and form through the walking city, the networked city, and the development of the suburbs.

79-244 Pittsburgh and the Transformation of Modern Urban America

Intermittent: Mini Session - 6 units

This mini course will focus on the transformations, both negative and positive, of the city of Pittsburgh and of the Pittsburgh region in the period from 1945 through the present. It will explore the following themes: the redevelopment of the city in the Pittsburgh Renaissance (I & II), the collapse of the steel industry and the development of a service economy, the city's changing demography, suburban development, neighborhood decline and renewal, and environmental policy and change.

79-247 Family, Gender, and Sexuality in European History, 500-1800

Intermittent: 9 units

The medieval and early modern periods witnessed a transformation in the cultural and social understandings of gender. During this period, the mutable sexual categories of the pre-modern world evolved into the definitions of masculinity and femininity recognizable today. This course examines these changes in the understanding of gender and the family in Europe in the medieval and early modern periods, drawing upon readings in gender history, marriage and the family, and the history of sexuality. We will explore the ideal of Christian marriage and family and examine how the "ideal" compared to the reality on such issues as marriage practices, family, gender roles, and sexuality. We will also explore the fashioning of female and masculine gender norms and the construction of the male and female sense of self over time. In the process, we will examine the larger historiographical issue of the use of gender as a tool of historical analysis.

79-248 History and Theory of Property: Land, Bodies, Ideas and Information

Intermittent: 9 units

This course surveys the changing relationship between private property and the public domain from the Roman Empire to the present. In the first part of the class, we will explore the roots of our present day property regimes: the land enclosure movement in early modern England (the conversion of common lands into private estates); and the development of intellectual property protection in Anglo-American law. We will also examine the slave laws of ancient Rome and the antebellum United States, as well as some representative non-Western views of property, including those of Native Americans and the Chinese. In the second part of the course, we will examine how concepts of property have recently expanded to include works of art and culture, software code, materials shared via the internet, various forms of information, one's own body, cell lines, and regions of the genome. We will conclude with a discussion of how Western ideas of property are being spread around the world through international trade agreements at the same time that they are being contested and rethought in their places of origin.

79-251 Flesh and Spirit: Early Modern Europe, 1400-1800

Intermittent: 9 units

This course examines European history from the Black Death to the French Revolution, a period known to history as the "early modern" period. That is, it marks a period in European history that was not quite medieval, and yet not quite modern. Many features of modern society, such as the nation-state, free-trade economies, religious pluralism, scientific rationalism, and secular culture trace their origins to the early modern era, yet the period was also marked by important continuities with the Middle Ages. During this course, we will explore how Europeans re-imagined their world in its transition from the medieval to the modern. Topics to be considered will include the "renaissance" of the arts, the problems of religious reform, exploration and colonialism, the rise of science, and the expansion of the state. Through these developments, we will focus on Europeans' changing notions of the human body, the body politic, and the natural world, as well as their re-interpretations of the proper relation between the human and the divine, the individual and the community, and the present and the past.

79-253 The Development of Caribbean Culture

Intermittent: 9 units

This course is a general introduction to Caribbean histories and cultures, from before the arrival of Columbus to the present. Comprised of dozens of islands, the Caribbean has been a stage for the encounter of multiple empires and peoples-indigenous, European, African, and Asian. It remains an area of remarkable linguistic, religious, political, and ethnic diversity in the present. In this course we will explore some of the major themes that have characterized the region's many histories and cultures: the early cultural encounters of the period of conquest and colonization; the Atlantic slave trade, the emergence of plantation societies, and patterns of slave resistance; nationalism, imperialism and revolution; and the place of migration, popular religion and tourism in the contemporary Caribbean. Through the exploration of such topics as Negritude and Rastafari, and such media as music and film, this course will place the connections between politics and culture at the center of our encounter with the Caribbean's complex historical past.

79-254 Hawaii: America's Pacific Island State

Intermittent: 9 units

This semester, we are focusing on Hawaii--a Pacific Island, an American state, and a popular tourist spot. Hawaii at once fills our imagination and occupies a strategic niche in United States policies. The story has not always been positive: we will take a historical perspective on the changes in Hawaii over the past two and a half centuries, and we will explore the culture of the islands. We will read accounts by "outsiders" and accounts by kama'aina, "children of the land," residents of Hawaii. We will also consider representations of the islands in media other than text, films, for instance, and visual arts. The goal is to explore the complexity of a place that is often stereotyped as "paradise," but exemplifies problems of conquest and commercialization, of ethnic groups and boundaries, of commercialization and globalization, and of identity politics and independence movements. Readings include anthropological texts, literature, and selected essays.

79-255 Irish History

Intermittent: 9 units

This course surveys Irish history from the earliest human settlements until the present day, with emphasis on the period since the sixteenth century. Our main objective is to understand the sources of conflict in modern Ireland. In order to do that, however, we look at a number of topics such as the role of religion in Irish society; the causes of population growth, movement and decline; changing forms of protest; and the formation of rival myths of the Irish past and its meaning.

79-256 Biology and Society: Evolution, Animal Experimentation and Eugenics

Intermittent: 9 units

This course focuses on the relationship between biology and society in Britain, Continental Europe, and the United States in the 19th and early 20th centuries. We will examine the ways that biology and society evolved together during this period, and became increasingly reliant on one another in the process. The first part of the course will cover the development of evolutionary thought, especially Darwin's theory of evolution by natural selection. In order to gain a full appreciation of Darwin's accomplishments, we will examine the scientific, religious, political, and philosophical ideas that influenced him. We will also explore the influence of Darwin's theory in all realms of society. The second part of the course will be devoted to the rise of experimentalism in biology. As part of this unit, we will explore the early history of genetics and its social application in the form of eugenics. The course will culminate with an analysis of the

scientific and moral debates about animal experimentation that took place in the mid-19th century as Western conceptions of humanity's place in nature were changing dramatically.

79-257 History of the American Working Class

Intermittent: 9 units

This course will examine the transformation of the American working class from its preindustrial origins to the recent period of deindustrialization. It will emphasize the changing relationship between owners, managers, and workers, the role of the state, and the impact of gender, race, and ethnicity. More specifically, this course will not only analyze the factors that facilitated and/or impeded working class solidarity, but assess the impact of the working class upon the development of American history.

79-258 Introduction to African History II: 18TH Century to Neo-Colonialism

Intermittent: 9 units

The course is designed to give students an understanding and appreciation of African history and culture from the "inside out." Though it deals with the period of European expansion in Africa, it is centered on African language/ ethnic groups, villages, and individuals as historical actors who daily make collective and personal decisions to pass down, innovate, and borrow practices, technology, spiritual systems, etc. in the face of social, political, and economic realities. The course is also designed to get students thinking critically about how historians select and interpret sources to construct and reconstruct history at these different levels.

79-259 Introduction to Religion

Intermittent: 9 units

The objective of this course is to introduce students to the variety of intellectual disciplines by which religions can be studied and some of the topical concerns of Hinduism, Buddhism, Judaism, Christianity and Islam. Topics to be covered in the course include: What is religion? Religious studies vis-à-vis historical, anthropological, sociological, and psychological approaches to religion; the sacred/holy; myth, symbol; society and the sacred; deity; cosmogony, religious anthropology, theodicy; ethics, eschatology and secular humanism in the modern age.

79-260 Mayan America

Intermittent: 9 units

This course will explore the history and culture of the Maya from before the European conquest of the Americas to the present. After a survey of pre-Hispanic Mayan societies and of the European conquest of Mexico and Central America, we will consider the experience of the indigenous Maya under Spanish colonial rule and under the rule of Latin American nation-states in the nineteenth and twentieth centuries. Finally, we will cover the recent history of political conflict and military repression in Guatemala, the Zapatista uprising in southern Mexico, and increasing Mayan migration to the United States. Drawing upon the varied perspectives of archaeology, cultural anthropology, and social history, this course will explore several recurrent themes in Mayan America, such as: conquest, adaptation and resistance; indigenous political and communal organization; popular religion; Mayan cultural and ethnic identity; "tradition" and "modernity"; state violence and human rights; and indigenous political and cultural mobilization at the local, national, and transnational levels.

79-261 A History of Asian Americans in the United States

Intermittent: 9 units

Immigration has been a major transforming force in American history. In the past forty years the population of Asian Americans in the United States has increased dramatically and has become much more diverse. New groups have joined the earlier Chinese, Japanese, Koreans, Filipinos, and Asian Indians, and they range from peasants to Ph.D.s. In this course we will trace the history of Asian immigration to the United States and examine how historical, social, political and economic factors have both affected and been affected by this migration. We will identify and discuss the common experience of migrants across a number of time periods and Asian ethnic groups, as well as the differences that make each group's story unique. Finally, we will examine the evolution of American responses to these various immigrant groups, questioning whether the responses reflected or helped to shape the opinions of Americans in the respective time periods.

79-263 From Soil to Oil: Energy and the Environment in the Americas

Intermittent: 9 units

The world we live in is marked by the accelerated movement of capital, goods, and people across borders. All of this movement, whether it occurs across physical or virtual space, requires energy

- lots of energy. For most of recorded history, human societies derived energy from a "biological regime" that included soils, plants, animals, and water. This changed dramatically in the twentieth century, when the transition to a "fossil fuel regime" enabled unprecedented rates of consumption and wealth accumulation while contributing to equally unprecedented rates of ecological change. This course will use lecture, readings, film, and fieldtrips to explore the political, economic, and ecological dimensions of this great transformation by focusing on the Americas. Our approach will be both comparative and transnational in order to highlight both national differences and regional connections. Students will write short response papers and a research paper.

79-267 Pre-Colonial West African History: 1100 to 1800
Intermittent: Mini Session - 6 units

This course examines major themes in pre-colonial West African history, Islamization, urbanization, economic specialization, identity formation, interregional and trans-Atlantic trade, and European conquest. The focus of the course is on indigenous social processes and institutions and their evolution as West Africa becomes an important part of the wider Islamic and Atlantic worlds. Students will be introduced to a variety of interdisciplinary sources as we reconstruct a history which in some cases pre-dates and in others is not recorded in written sources.

79-268 From the Local to the Global: Globalization in East African History
Intermittent: Mini Session - 6 units

Most Americans would identify slavery and colonialism when thinking of Africa's relationship to the rest of the world. While these two institutions have been critically important in shaping Africa's present condition and recent history, they only constitute a fraction of Africa's past and its interaction with the wider world. This course traces globalization to ancient times and seeks to understand it from an African perspective.

79-270 Chinese Culture and Society
Intermittent: 9 units

Few courses provide an opportunity to look at a civilization as a whole. If we examine the Chinese quarter of humanity in this way, we can better understand the interplay of ecology and history, of class and community, and of self and society in China-and in any other society. We may also gain a new perspective on the West, whose peculiarities we too readily take as normal. This introductory course focuses on Chinese solutions to Chinese problems, as reflected in the words of the literate (e.g., philosophers and soldiers, dramatists and novelists) or in the actions of the unlettered (e.g., peasants, women and religious cultists). We proceed by making explicit their values and ours, setting up a kind of discourse across cultures. Special attention is paid to the seventeenth and eighteenth centuries.

79-271 Modern China
Intermittent: 9 units

Assuming no prior familiarity with China or its culture, this course examines China's continuous changes from the 1800s on, in its cultural traditions, identities, daily life, social relations, and self-perceptions, engendered by both internal initiatives and external contact. We look at how changes unfolded in mass movements and in individual lives, in statecraft thought and in societal practices. We examine the roles of such historical actors as the extended family, modern reformers, the state, the parties and ethnic groups. Participants learn to use primary sources in making historical observation and to critique some analytical approaches to modern Chinese history. Since we rely heavily on assigned readings, active class participation is essential in this course.

79-275 Religious Identities and Religious Conflicts in Nineteenth-Century Europe
Intermittent: 9 units

This course explores the place of religious identity and conflict in the history of European society from the French Revolution to World War I. We study the many ways that individuals constructed and used their religious identities to approach problems of public life. We examine continuities and changes in religious institutions as well as conflicts between churches and states. The course shows that, far from declining in importance during the processes of economic and political modernization, or becoming part of private life, religious beliefs and identities played an increasing critical role in public life. We approach the topic through case studies, beginning with the religious conflicts and settlement between church and state during the French revolution, Evangelical Christian participation in the anti-slavery movement in Britain, Protestant-Catholic rivalries in Germany, the power of the papacy in Italy, and the Dreyfus case in France. Students will have reading assignments from both primary and secondary sources.

79-276 North of the Border: Mexican Immigration Past and Present
Summer: 9 units

Recently we have been bombarded with information about Mexican immigration, much of which is inaccurate or incomplete, much of which is highly charged emotionally and politically. This phenomenon of movement to the north has a long and complex history with many dimensions, a history important to understand because what we believe about the past influences our perceptions of the present. In this course we will explore, among other things, the historical reasons behind the economic and social dislocations of Mexican immigrants, impact on both the sending and receiving communities, their integration into the U.S. economy, the changing destinations and demographics of the more recent immigrants, and barriers and facilitators to integration and mobility.

79-278 China's Environmental Crisis
Intermittent: 9 units

In the context of China's changing ecology, this course explores whether and how sustainable development has been, is being, and might be pursued by its vast population and political leadership. Without neglecting culture--e.g., Confucian, Daoist, Buddhist and Altaic (steppe) views of ideal human/environment interaction--we trace historical demographic patterns and their effects on China's fauna and flora, and investigate past government efforts at water control, migration, new crop introduction, natural disasters, etc. Over half of the course concerns the People's Republic (1949-), paying special attention to birth control policies, the steppe reclamation, the Three Gorges dam, industrial growth, pollution scandals, tourism and environmental policy. We work mostly by discussion, centering on materials read in advance by class members. Mid-term and final exams, and two five-page papers on set topics.

79-280 Russian History from the First to the Last Tsar
Intermittent: 9 units

This course covers a broad sweep of Russian history beginning with the first settlements of tribal nomads in the ninth century and ending with the fall of the 300-year-old Romanov dynasty in 1917. In our study of Russian colonization and state formation, we make the acquaintance of Mongol marauders, greedy princes, and peasant rebels, as well as Ivan the Terrible, Peter the Great, and the long succession reformers and reactionaries who occupied the Russian throne. We explore the development of a working class, and the uprising of workers, peasants, and soldiers that ultimately brought down the Tsar.

79-281 Russian History: From Communism to Capitalism
Intermittent: 9 units

This course covers a broad sweep of Russian history from the socialist revolution in 1917 to the turmoil of the present. Spanning almost a century of upheaval and transformation, the course examines the October revolution, the ruthless power struggles of the 1920s, the triumph of Stalin, the costly industrialization and collectivization drives, the battle against fascism, and the "wild west" capitalism and collapse of the social welfare state in the present time. The course provides essential background for anyone interested in understanding the explosive, history-making events in the former Soviet Union.

79-282 The Soviet Union in World War II: Military, Political, and Social History
Intermittent: 9 units

On June 22, 1941, Hitler invaded the Soviet Union. German troops quickly reached the hills above Moscow, surrounded Leningrad in the longest running siege in modern history, devastated the country's economy, and slaughtered millions of Soviet civilians. Eventually, the Red Army came back from defeat to free the occupied territories and drive Hitler's army back to Berlin. This course examines why and how the war was fought. Using history, films, poetry, veterans accounts, documentaries, and journalism, it surveys the rise of fascism, the Stalinist purges of the Red Army, the Hitler-Stalin pact of 1939, the Nazi massacres of Soviet Jews, peasants, and partisans, life on the home front, and the great battles of the war. Occasional Thursday evening film screenings.

79-284 Family and Gender in Russian History
Intermittent: 9 units

Using film, novels, interviews, and historical sources, this course will explore the history of gender relations, the family, and women in Russia. Beginning in the late nineteenth century, we will explore family relations in both noble and peasant families, the laws governing marriage, divorce and children, restrictions on women's movement and education, and gender roles. We will look at the explosive changes of the Russian revolution and the radical experiments with free love and communal childrearing. We will

trace the development of opportunities for women in the 1930s, the painful demographic impact of WWII, and the changing culture of the post war years. We will end by examining the difficulties that rural and urban families are currently facing in the transition to a market economy.

79-286 African Americans in Pittsburgh

Intermittent: Mini Session - 6 units

This course will examine the development of Pittsburgh's African American community from the Great Depression and World War II through the era of deindustrialization during the late 20th and early 21st centuries. The course will emphasize not only the ways that a variety of external socioeconomic, cultural, and political forces shaped the history of black people in western Pennsylvania, but also the diverse strategies that African Americans devised to give meaning to their own lives and how these changed over time. Students will read both primary and secondary accounts of Pittsburgh's African American history; write short analytical papers on specific topics or themes; and engage in regular classroom discussions of assigned readings.

79-288 Bananas, Baseball, and Borders: A History of Latin America - US Relations

Intermittent: 9 units

Consider this: The U.S. government maintains an economic embargo on Cuba even as Cuban musicians like the Buena Vista Social Club enjoy wild popularity in the United States. Former left-wing guerrillas in El Salvador resent the U.S. government for its past support of military dictators while they anxiously await for money to be sent from their cousins who clean office buildings in Washington DC. North Americans donate money to protect tropical forests while they consume enormous quantities of bananas grown where rainforests once stood. This course will attempt to make sense of the tumultuous and paradoxical relationships between Latin America and the United States from the early 1800s to the present. The course will go beyond state-to-state diplomatic relations in order to explore the economic, social, and cultural dimensions of the often intimate ties between the two regions. Readings and other course materials will focus on U.S. encounters with Mexico, Central America, Cuba, and the Andean nations.

79-289 Development and Democracy in Latin America

Intermittent: 9 units

This course will use readings, discussion, film, and music, to explore development and democracy in Latin America. Beginning with the Mexican Revolution (1920s) and ending with Hugo Chavez's on-going "Bolivarian Revolution" in Venezuela, we will approach development and democracy as historically contested concepts that gave rise to a diverse range of practices and institutions. Specific regions and topics covered include export economies and civil wars in Central America; industrialization and populism in Argentina; gender, socialism, and dictatorship in Chile; and indigenous people and drug wars in the Andes. Students will write short response papers and a research paper.

79-290 Between Revolutions: The Development of Modern Latin America

Intermittent: 9 units

When the Haitian Revolution began in 1789, everything south of the newly created United States was under European colonial rule, slavery was an established institution, and the Catholic Church held considerable power over the daily lives of people. However, when the Mexican Revolution began in 1910, Spanish and Portuguese colonialism had collapsed along with slavery, and the power of the church had greatly diminished. New societal institutions emerged that reflected novel ideas about the role of secular nation-states, "free market" economies, and the meanings of "civilization." This course will use scholarly writings, fiction, film, and video to analyze the profound changes that took place in Latin American society during and between these two important revolutions. We will pay attention to the lives of both elites as well as the "everyday" people who helped to shape the region's history.

79-292 Industrial America

Intermittent: 9 units

This course examines the transformation of America into an urban industrial society during the 19th and 20th centuries. It analyzes the major economic, demographic, political, and social consequences of industrialization with emphasis on race, class, and gender. We will pay particular attention to the lived experience of workers who witnessed this transformation firsthand.

79-293 20th Century China Through Film

Intermittent: 9 units

This course is about both film and history. It does not pretend to be a history of film, but it is both an introduction to some issues of modern Chinese history and an examination of how that history is treated in film, especially Chinese film of the past twenty years. We have selected some well-made films exploring some key issues of 20th century history, including several of Zhang Yimou's works, documentaries made in the U.S. with Chinese assistance, and works by leading Italian, Taiwanese and Chinese American directors. In a few cases themes will be illustrated in excerpts. The readings consist of topical articles and book chapters, tied together by a general history of the period. The once-a-week evening sessions will normally begin with a film viewing and conclude with discussion initially in sections. Varied weekly assignments, some of them collaborative, will explore the social context and methodology of the films, developing critical skills in writing, observation, film, and historical imagination.

79-294 The Making of the African Diaspora in the New World

Intermittent: 9 units

The trans-Atlantic slave trade dispersed Africans in the New World and the Old, creating the African Diaspora. Generations of scholars have disputed whether descendants of enslaved Africans could have retained any of their African culture and/ or fully assimilated into New World societies. This course will combine a chronological, geographical, and a thematic approach to the creation of new Africa-inspired cultures in both Africa and the African Diaspora. It will explore societies in the Caribbean, the US South, Latin America, and Africa and address themes, such as Africanisms, African survivals, African retentions, Creole languages, and religion.

79-295 Germany and World War II

Intermittent: 9 units

This course examines the Second World War from the perspective of the country that was central to it in every way. The course will cover: Hitler's ideology, war plans, and military strategy; the military/ technological history of the War in Europe and North Africa; the role of the SS; the Holocaust; the occupation of Europe and Resistance movements; the political, social, and economic history of the Third Reich, including popular opinion, the German Resistance, and the use of slave labor in factories and on farms. Readings will include historical studies, a novel, and a memoir/diary. Students will watch a number of films about the War on Thursday evenings (along with students enrolled in The Soviet Union and the Second World War).

79-296 Genes, Clones and Stem Cells: Biology and Society in the 20th Century and Beyond

Intermittent: 9 units

This course examines the historical, political, cultural, and ethical dimensions of genetics, developmental biology and reproductive medicine from the beginning of the 20th century to the present. Particular emphasis will be placed on: 1) charting the growth of scientific knowledge about life processes; 2) analyzing how cultural and social context deeply affects the production of biological knowledge; 3) understanding the central role of the life sciences in shaping the way we think about ourselves and our world; and 4) critiquing the ways that biological knowledge is portrayed in the public sphere by both scientists and the media. Topics covered will include: the discovery of the structure of DNA; the emergence of ideas about embryonic development; the nature/nurture (sociobiology) debate; the cloning controversy; the stem cell debate and the politics of abortion; the Human Genome Project and its offspring; the commercialization of biology in the late 20th century; and the ethical dimensions of reproductive medicine (i.e., genetic screening, sex selection and IVF).

79-299 US-Arab Encounters

Intermittent: 12 units

What is the nature of the relationship between the United States and the Arab countries? This is an innovative cross-cultural course that will enable CMU students in Pittsburgh and at the CMU campus in Qatar to interact with one another and with students at other American and Arab universities in exploring the US-Arab relationship. The goal is to improve awareness and understanding. Students will delve into themes and questions within an interdisciplinary framework that includes history, international relations, conflict resolution and media studies. Topics range from the role of religion in society to an investigation of the part media plays in shaping US and Arab perceptions. CMU students in Pittsburgh and Qatar will utilize the newest web-camera and videoconferencing for the traditional in-class part of the course and enjoy a chance to work collaboratively on projects with students elsewhere in the US and the Arab world via an on-line discussion forum. Students registering for this class should be prepared for a

substantial time commitment to allow for the opportunity to meet and work in real time with students far from Pittsburgh. Participating schools include: Tufts, Harvard, Clark, Virginia Commonwealth, Birzeit, Qatar, American University of Cairo, American University of Beirut, and Philadelphia University (Jordan).

79-301 African Entrepreneurs/Entrepreneurs in Africa: Past, Present and Future
Intermittent: 9 units

Fifty years after Ghana, the first sub-Saharan African nation, gained its independence from colonial rule, African economies continue to rest on a fragile foundation. Entrepreneurs must play an important role in developing the African continent, because both African governments and foreign aid have overall failed. In the face of these myriad of internal and external constraints on economic development, the history of entrepreneurship and future potential for entrepreneurship is often overlooked. This course will show that sub-Saharan Africa is—and has been for centuries—a thriving place of business, despite the obstacles of war, political and economic instability, disease, and famine. It will also focus on the challenges, such as local, regional, and national integration, access to credit and capital accumulation, and debt burden that African economies faced in the past, present, and future. Lastly, it will focus on the strategies that entrepreneurs in Africa—local and foreign—have developed to circumnavigate these challenges—and the opportunities that they have created in spite of them. By taking a historical approach to the subjects of entrepreneurship, innovation, and technology in Africa, this course will define African entrepreneurship in a way that is rooted in Africans' historical experiences and use this definition to put Africa's current and future roles in the global economy into historical perspective.

79-303 Visual Anthropology

Intermittent: 9 units

Visual anthropology is a subdiscipline of anthropology with a long and complicated history. We begin with a specific aspect of visual anthropology: photography and film. Both photography and film have raised important theoretical and methodological questions for anthropologists; these include concerns about the power of the person behind the camera, the connections between cultural values and visual representations, and the importance of the "visual" to assertions of cultural identity and autonomy. At the end of the semester, we will open the discussion to newer media, including a discussion of the impact of the Internet on anthropology as a discipline. Do the same questions about power, ethics, representation, culture, local and global arise in the early 21st century as arose at the beginning of the 20th century? Specific topics include: the camera and fieldwork methods; the relationship(s) between "observer" and "subject;" the influence of commercialization and the market; new technologies and aesthetics; the politics of representation and the significance of the visual in forming policy; the impact of the Internet on cultural diversity.
Prerequisites: 79201

79-306 African American Urban History

Intermittent: 9 units

This course will explore the African American urban experience within the larger context of U. S. urbanization. Specifically, it examines the African American encounter with cities on the Atlantic seaboard during the colonial era; the rise of Midwestern cities during the 19th century; the emergence of the Great Migration during the 20th century; and the increasing suburbanization of the black population during the late 20th and early 21st centuries. While the course will illuminate the impact of larger U. S. urban economic, political, and cultural developments on black urbanites, it will emphasize the role that African Americans played not only in the creation of their own urban communities, but in the transformation of American urban life itself. Students will read both primary and secondary accounts of African American urban history; write analytical papers on specific topics or themes; and engage in regular classroom discussions of assigned readings.

79-307 The Anthropology of Europe

Intermittent: 9 units

This course provides a broad introduction to anthropological perspectives on European cultures in order to address some of the most important issues that arise in the study of complex societies. Among the topics that will be considered are the common themes of European cultures and the shifting meanings that have been assigned to the concept of "Europe"; the variety and diversity of European experience; and the role of local, regional, class, and national forms of identity in shaping social life. Special attention will be given to the relations between Eastern and Western Europe, the causes and dynamics of contemporary ethnic conflicts, and the problems involved in creating a liberal and democratic European

Union. In addition, we will consider what contribution the study of Europe has to make to the development of anthropology, a social science that has traditionally been oriented to the study of non-western societies.

79-308 The Politics and Culture of Memory

Intermittent: 9 units

How do societies remember? Memory is social, rather than simply individual, in scope. It is cultural, rather than purely psychological, in nature. Its significance is as political as it is personal. Traversing the globe and moving from the distant past to the immediate present, this course brings a comparative and anthropological perspective to the politics of cultural memory. It explores the wide variety of media through which memories are produced and conveyed from written histories to oral performances, from monuments and museums to film and photography. We will begin by surveying the different ways in which the study of memory has been defined and will proceed to the close study of how memory works in several non-Western societies. Then we will explore the role of memory in the making of nations and families, in the formation of class and gender identities, and in recollecting and responding to the violence of slavery, colonialism, and genocide. Finally, we will consider the place and politics of memory in the writing of history by professional historians.

79-309 Public Policy and American Military Recruitment: Historical Perspectives

Intermittent: 9 units

This course examines a number of major policy choices in recruiting American men and women into military service, and the political and cultural controversies that have surrounded those choices, from the late 18th century to today (with the focus on World War I to the present). The main topics to be covered -- all from a historical perspective -- will likely include most or all of the following: 1) the draft, the all-volunteer military, and the Reserves/National Guard as methods of military recruitment; 2) the exclusion/incorporation of African Americans, women, and gays into military service; 3) the recruitment and training of enlistees and draftees; 4) the recruitment and training of military officers; and 5) protest movements against military recruitment. The course will be discussion based and centered on analysis of required readings for each class.

79-310 Modern Spain: Culture, Politics, and Society

Intermittent: 9 units

This course provides an overview of Spain from 1898 until the present. Drawing on the work of historians, anthropologists, and a wide range of writers and artists, the class will consider: the origins and events of the Spanish Civil War of 1936-1939; the character of the Franco dictatorship; the transformation of rural and urban society and culture that occurred between 1939 and 1975; the transition to liberal democracy in the 1970s and 1980s, and the "Europeanization" of Spain since the 1990s.

79-312 Medical Anthropology

Intermittent: 9 units

This course will explore the ways in which different cultures conceptualize the body and its relation to the physical, social, and supernatural environments. We will examine how illness and its causes are understood, investigating not only the beliefs and practices surrounding healing, but also the social position and training of the healers themselves. In order to understand the context of healing in cross-cultural perspective, we will problematize the boundaries between medicine and other arenas of social life: religion, politics, law, economics, etc. We will investigate issues of medical efficacy (what "works?") by asking who or what is being healed in different kinds of medical practices, and we will consider the ways in which power and social control are exerted through medical discourses of various sorts. Finally, we will examine the history of medical anthropology from its "clinical" origins in international development, through anthropological critiques of clinical perspectives, to attempts to fuse clinical and critical approaches. Throughout the course, Western medical practice will be analyzed as one of many forms of ethnomedicine and ethnopsychology.

79-314 Nationalities and the New States of the Former USSR

Intermittent: 9 units

Until its collapse in 1991, the Soviet Union was a world superpower incorporating within its borders the great landmass of Europe and Asia-modern Eurasia. Conditioned to view the Soviet state as a unified great power, many people have found it difficult to comprehend the rapid dissolution of this once mighty empire. Analysis of the nature of "ethnicity" and "nationality", as well as nationalism and policy toward the nationalities in the former Soviet Union, will form the background for analyzing the economic, social,

political, environmental, military and foreign policy issues that have arisen within and among the new states today.

79-315 History, Memory, and Patriotism in America

Intermittent: 9 units

Although Alexis de Toqueville claimed in the 1830s that Americans had no reverence for history, in fact we have always battled over how best to remember and commemorate the nation. Frederick Douglas caused a furor in 1852 when he declared that Independence Day was a mockery for African Americans; the 1995 controversy over the Smithsonian Institution's Atomic Bomb exhibit underscored that the tensions between history, memory, and patriotism remain deeply political. This is a course about how Americans remember and reshape their collective past to serve their particular present.

79-316 America in the Age of Lincoln

Intermittent: 9 units

After 7:22 a.m. on April 15, 1865, Abraham Lincoln "Belonged to the Ages." In the century since his assassination, Americans have fought bitterly about who he was and what he continues to mean to different segments of the nation. Honest Railsplitter or Slick Lawyer? Great Emancipator or racist opportunist? Savior of the Union or demagogic tyrant? Students analyze Lincoln's own views along with the ways he has been remembered and used by politicians, protesters, poets, advertisers, and Hollywood filmmakers.

79-317 Historical Memory and Historical Sources: Reconstructing Africa's Unwritten Past

Intermittent: 9 units

Historians of Africa, particularly of the pre-colonial period, inevitably face two key questions: How do we reconstruct the past without written sources? And, how do we interpret written sources to document development and change in Africa's past when the overwhelming majority of these sources were written by non-Africans? In this course, we will examine a variety of "non-traditional" historical sources which allow us direct access to "Africans' voices" such as historical linguistics, oral traditions, oral histories, and ethnographies. After studying the methodologies that historians use to interpret these non-traditional primary sources and studying examples of historians' interpretations of them, we will read examples of the primary sources ourselves. This course is designed to give students new analytic tools with which they can look at all kinds of history.

79-318 Protest, Propaganda, and the Public Sphere, 1500-1800

Intermittent: 9 units

The advent of the printing press created unprecedented opportunities for the spread of new ideas in early modern Europe. Throughout the period, Europeans harnessed the power of print to mobilize opinion and effect change. This new print culture, combined with powerful images and a lively mix of gossip, rumor, and popular song, played a pivotal role in the revolutionary changes of this dynamic age. This course explores the popular protests of the early modern era through the propaganda that fueled them: the pamphlets, ballads, rumors, and cartoons that spread the message of change and galvanized popular support. In particular, the course will focus on the role of such propaganda in three critical moments of early modern European history: the German Reformation, the English Civil War, and the French Revolution. In the process, we will explore such historical problems as the cultural consequences of the coming of the book, the impact of censorship, the emergence of the "public sphere," and the rise of popular politics and public opinion as recognized forces in European political life.

79-319 The City and the Country in Modern Europe

Intermittent: 9 units

This course focuses on modern European culture and politics through the lens of the relationship between urban and rural life. Drawing on historical, literary, and anthropological sources, the class will first explore how representations of the city and the countryside have continually shaped and been shaped by Europeans' understanding of history, geography, society, and the nation-state. After this broad overview, we will proceed by examining a set of topics that reveal the primary forces that have led to radical changes in both urban and rural life since the 1950s in the countries of western Europe. Among the topics that will be considered are migration, consumerism, tourism, the spatial organization of class and ethnic identity, recurrent crises of industry and agriculture, environmental movements, the impact of mass media, the conduct of democratic politics, and the development policies of the European Union. Throughout the course our main concern will be to understand how these general forces have generated conflicts over power and values that have transformed the everyday experience and sense of possibilities for the future of ordinary Europeans who live in very different kinds of urban and rural communities.

79-320 Women and Power

Intermittent: 9 units

This course examines the history of women's rights agitation in the United States from the early nineteenth-century to the present. It investigates both well-known struggles for women's equality--including the battles for women's voting rights, an Equal Rights Amendment, and access to birth control--and also explores the history of lesser-known struggles for economic and racial justice. Because women often differed about what the most important issues facing their sex were, this course explores not only the issues that have united women, but also those that have divided them. Do women constitute a coherent category? And can a women's rights movement represent all women? These are some of the questions at the heart of this class.

79-321 Picasso and 20th Century Art

Intermittent: 9 units

The greatest artist of the twentieth century, Picasso, invented or participated in most of the major styles of modern art. His artistic genius and visual inventiveness will be explored from 1894 (age 13) to his death in 1973 (age 92), against the background of eight decades of modern art. The focus of the investigation will not be limited to psychological and iconographic factors, but will be discussed in the historical and artistic context of his time.

79-324 Modern Painting

Intermittent: 9 units

Examines the birth of modern painting in its historical context. Through understanding the major styles and successive movements in the development of modern art, students explore the many relationships of artist and artwork with parallel works in other media such as literature, music and film, and with parallel trends in intellectual and social history.

79-325 Art and Religion

Intermittent: 9 units

The Art and Religion course will explore several major artistic manifestations prompted by religious beliefs during the history of art. Emphasis will be on the arts; however, general historical, eschatological, and philosophical explanations will be attempted. Major religions will be brought to discussion in one or several of their artistic manifestations.

79-329 Sex, Population, Birth Control

Intermittent: 9 units

This course will explore efforts to control reproduction in the United States in the 19th, 20th, and 21st centuries. Topics include: the changing status of birth control and abortion in the context of law, medicine, and public policy; the relationship between women's rights and reproductive rights; the eugenics movement and involuntary sterilization laws; the relationship between birth control and population control; the development and impact of new contraceptive technologies; infertility and the development and use of new reproductive technologies; changes in sexual attitudes and practices; and the impact of AIDS and other sexually transmitted diseases on sex and birth control.

79-330 The American Presidency

Intermittent: 9 units

The presidential election campaign offers a context for raising some important questions about the American Presidency as it has evolved over its two centuries of existence. Among them are: How has this kind of leader functioned in the kind of society the United States has become? What political and social roles have Presidents played? How much power, and what kind of power, have they had, and how did they get it, use it, and perhaps lose it? In producing Presidential effectiveness, how crucial have individual character and personality been?

79-332 Juvenile Delinquency: Images, Realities and Public Policy, 1800-1940

Intermittent: 9 units

This course will examine juvenile delinquency in historical, sociocultural, and policy contexts during the past two centuries, and will focus mainly on the United States up to World War II. Three themes will be emphasized: 1) changing legislative, judicial, correctional, and therapeutic attempts to define, punish, and rehabilitate "delinquent" youth; 2) behavior patterns of youths labeled "delinquent," and how their behaviors changed over time; and 3) images of "delinquents" as portrayed in film, social science scholarship, government reports, and newspapers. The course will be run in a discussion format. Readings will be drawn from historical, sociological, psychological, literary, and journalistic accounts of juvenile delinquency.

79-333 History of Biomedical Research

Intermittent: 9 units

This course examines the development of biomedical research in the nineteenth and twentieth centuries, focusing primarily on the U.S., but also examining research and institutional models in Germany, France and England. Beginning with the work of Pasteur and ending with an examination of the research infrastructure supported by the National Institutes of Health in the late twentieth century, the course examines the following themes: the production of scientific knowledge as a social process; the building of a biomedical research infrastructure; the balance between social accountability and scientific independence of the research enterprise and relationships with research patrons such as government, industry and academia. In addition, the course examines the formation and reformation of biomedical disciplines and the building of the biomedical education infrastructure, with emphasis on pharmacology, physiology, immunology, neuroscience, and genetics.

79-335 Drug Use and Drug Policy

Intermittent: 9 units

This course examines the use of psychoactive drugs in American history, as well as medical, scientific, and policy responses to that use. Drugs we will consider include alcohol, heroin, marijuana, tobacco, and cocaine. We will examine changing theories of addiction, ethnographic studies of drug using groups and the cultural meanings of drug use. We will also consider drugs as commodities in international trafficking. Although the primary focus is on the U.S., we will look at policy approaches to drug use in other countries as well, to put American drug policy in a comparative perspective.

79-336 Epidemic Disease and Public Health

Intermittent: 9 units

Epidemics of infectious disease are both biological and social events. Through the perspectives of the changing ecology of disease and social construction of disease, this course examines epidemics of such diseases as bubonic plague, cholera, smallpox, and AIDS. Besides considering the social factors that help determine the epidemiology of a particular outbreak of disease, the course analyzes human responses to epidemic disease. These responses include popular attitudes toward the disease and those who contract it, as well as public health measures intended to control spread of the disease.

79-337 Educational Policy in Historical Perspective

Intermittent: 9 units

Education policy is at the center of efforts to make our workplaces more competitive, our civic order more humane, and our schools more effective. Debates over educational policy have revealed the tension between public and private space, centralization and federalism, wealthy communities and poor. The special features of American educational policy and institutions are examined in the light of our historical experience and the institutional patterns and finances of other nations.

79-338 Childhood, Education, and Social Reform in American History

Intermittent: 9 units

In this course, we will examine several themes in the history of American childhood and education in the 17th to 21st centuries, and link them to 1) broad social changes that transformed the experience of childhood and 2) key policy changes that sought to enhance the status and well-being of children. While schooling will be a central focus, we will also study the evolving educational roles of other institutions, e.g., families, churches, workplaces, peer groups. We will also try to shed historical light on several contemporary educational controversies, such as desegregation, bilingual education, homework, sex education, religion in the schools, textbook bias, and school vouchers. Readings will center on scholarly books and articles.

79-340 A History of Modern Warfare

Intermittent: 9 units

Broadly conceived, this course examines the role of warfare in western society and history, during the period of emergence and expansion of western nation states. Central themes include the relationship of war to the state and its financial and managerial resources, to military technology, and to technological change in the means of production. Equally important are military leadership and the will to combat, both military and civilian. After an introduction to warfare from the classical period through the emergence of modern armies in the 17th century, the course focuses on major global conflicts from the Seven Years War through World War Two. Topics include the gradual evolution of European thinking away from classical ideas about warfare, and changing concepts of strategy,

tactics, and generalship as a result of industrialization and the emergence of global economic empires.

79-342 Introduction to Science and Technology Studies

Intermittent: 9 units

Science and technology (S&T) are among the most powerful transformative forces in today's global society. They simultaneously inspire utopian fantasies (unlimited economic growth and the end of human suffering) and conjure up dystopian nightmares (nuclear holocaust, environmental destruction, and "Frankenfoods"). This course provides an introduction to Science and Technology Studies, a vibrant interdisciplinary field that examines the ways that science and technology interact with contemporary politics, culture, and society. Using theories and methods from history, philosophy, anthropology, sociology, and public policy, we will examine the following topics: the nature of scientific and technical knowledge; the possibility of objectivity; expertise; risk; the realism v. social constructivism debate; race; sex and gender; science policy; and the public understanding of science.

79-344 Science, Technology, and the Cold War

Intermittent: 9 units

This course focuses on how the Cold War shaped the development of science and technology in the United States and the Soviet Union from its emergence in 1946 to the collapse of the Soviet Union in 1991. Although the course will treat the main topography of Cold War history, it focuses especially attention on the interplay among scientists, engineers, political leaders, and educational and scientific institutions in what one American president termed the "long twilight struggle."

79-345 American Environmental History: Critical Issues

Intermittent: 9 units

This course explores critical issues in the history of the American environment during the last three centuries. Among the specific topics to be covered are changing attitudes toward nature; forms of rural and urban development and environmental effects; the impacts of technology and industrialism; the conservation and environmental movements; and environmental problems and prospects today.

79-348 Objects of Value

Intermittent: 9 units

Value is a universal human concern, one that is as much spiritual and aesthetic as it is material. However, objects of value are produced, exchanged, circulated, consumed and understood in profoundly different ways. This course is an introduction to the anthropological study of objects of value in a variety of cultural and historical contexts. We will begin by considering how anthropologists have understood the exchange of objects as gifts, both in societies in which the exchange of objects as commodities is non-existent or rare, and in societies in which gift exchanges persist alongside or even within a commercial economy. Then, after considering the forms of barter and exchange that occurred during European expansion, conquest and colonization, we will explore commodity exchange, commodity fetishism, and money, in both Western and non-Western contexts. Finally, we will consider how anthropologists have explored the contemporary politics of value, addressing such issues as: globalization; migration and the "dollarization" of economies in Latin America and Eastern Europe; local, national and global political and economic crisis; and the emergence of new kinds of commodities and money, such as the Euro.

79-351 The Cold War in Documents and Film

Intermittent: 9 units

This course is based on use of historical documents and films to study problems which reshaped the world during and after the Cold War. We will examine how documentary and feature films depicted the most important events of the Cold War, such as the Korean War, the construction of the Berlin Wall, the Cuban missile crisis, and others. In addition to films, sources will include documents, lectures and readings.

79-352 The Arab-Israeli Condition: War & Peace

Intermittent: 9 units

This course focuses on the Arab-Israeli and Palestinian-Israeli conflicts, beginning with a historical overview and continuing on through current events. Emphasis is on primary source documents which are the milestones by which the direction of the conflicts and attempts to resolve them can be charted. Readings and discussion progress with a dual goal: to understand both the historical origins and contemporary parameters of the conflicts, and to consider the processes by which the conflicts may move toward resolution. The semester culminates in a sustained role playing exercise simulating an Arab-Israeli peace conference.

79-354 Stalin and Stalinism

Intermittent: 9 units

Joseph Stalin has been vilified and praised, damned and worshipped. He left behind a mixed and complex legacy: he created an industrialized modern economy in the Soviet Union, won a great and painful victory over the Nazis, built a police state, and destroyed the possibilities for socialist democracy. He sent millions of people to slave labor camps, and when he died, thousands wept at his funeral. This course will combine elements of biography and social history to examine Stalin, the man, and Stalinism, the phenomenon.

79-355 The American Skyscraper: Its History and Development

Intermittent: Mini Session - 6 units

Returning to America in 1904, the novelist Henry James complained that "monsters of greed" had transformed the New York of his youth into "a huge jagged city." During his absence, the skyscraper had been born from a marriage of technology and commercial growth, and was beginning-not without opposition-to dominate the country's urban skylines. Focusing on such major monuments as Adler and Sullivan's Wainwright Building (1891), William Van Alen's Chrysler Building (1930), and Mies van der Rohe's Seagram Building (1958), this course will trace the development of America's greatest contribution to the Western cityscape from the first "elevator buildings" of the 1870s, through the Art Deco towers of the 1920s and the gleaming glass monoliths that proliferated after World War II, to the Postmodern skyscraper of today.

79-356 Intro to African History I: Earliest Times to the Origin of the Slave Trade

Intermittent: 9 units

A beginning point for this course will be the question: how do historians reconstruct history when few written sources are available? Breaking disciplinary boundaries, the course will draw on linguistics, "climateology," archaeology, and anthropology to reconstruct dynamic social, cultural, political, and economic processes in Africa before the arrival of Europeans and before the availability of written source materials. When written sources are available, the course will interrogate them to illuminate the changes that occurred in African societies during the early period of contact with Europeans. Lastly, by focusing on long-term processes, such as economic specialization, urbanization, and Islamization, the course will begin to put the slave trade in an African-centered perspective.

79-358 Complex Technological Systems: Past, Present and Future

Intermittent: 9 units

The Internet is only the latest example of a complex technological system that fundamentally alters the way that we act in and think about our world—and about technology itself. During the last two centuries such complex technological systems have emerged, ranging from transportation systems such as the railroad and mass-produced automobiles running on paved roads and superhighways to networked information systems including the telegraph, the telephone, and radio and television. What are the common features of these complex technological systems? When do they emerge? How are national and international standards for these systems established? How far reaching are the consequences of these systems in society, business, and in other complex technological systems? Can they be predicted? Can they be controlled? Can such complex technological systems be fully comprehended and modeled? In a world in which many of these systems are interconnected, how vulnerable are current societies (such as those in the West) that depend on them, especially in an age of global terrorism? These are but some of the questions this lecture and discussion course will tackle using cases from the past, the present, and the future. Students are graded through weekly quizzes, midterm and final examinations, and class participation. Prerequisites: junior or senior standing.

79-359 History of African-American Families

Intermittent: 9 units

This course traces the development of family life, meanings, values, and institutions from the period of slavery up to recent times. The course engages long-standing and current debates about black families in the scholarship across disciplines (i.e. anthropology, sociology, and economics) and in the society at large. Course materials include secondary readings, primary sources, and films. The course will look at the diversity of black family arrangements and the way these have changed over time and adapted to internal and external challenges and demands. It will also situate the history of black families within a broader cross-cultural context.

79-362 Law and Disorder in Early Modern Europe, 1400-1800

Intermittent: 9 units

The growth of legal institutions and their expanding use in enforcing "social discipline" marked an important – and often controversial –

development in consolidating the political authority of the emerging states of the early modern era. This seminar will examine this process, looking at early modern European legal institutions and their role in defining and enforcing societal norms of conduct and belief. We will examine how the shifting definitions of "crime" within the period reflected prevailing societal attitudes and anxieties toward perceived acts of deviance and persons on the margins of society. In addition to the workings of governmental and legal institutions, we will also explore the ways in which early modern communities used informal social and economic sanctions to police communal standards, sometimes against the will of the authorities. Assigned readings will address such topics as the early modern European civil, criminal, and ecclesiastical court systems, investigation and punishment of crime, criminalization of social deviance (witches, vagrants, religious minorities and other outcasts), and the legal enforcement of sexual morality and gender roles.

79-363 The Rise of Modern Golf, 1860 to the Present

Intermittent: 9 units

Aristocratic pastime or the people's game? This course will examine the historical emergence of golf as both an amateur and professional sport and as a popular leisure activity in the U.S. between 1860 -- when Prestwick Golf Club in Scotland hosted the first (British) Open -- and the present. The course will be run as a colloquium, with students exercising considerable leadership responsibility for each class. Discussions will center on a wide variety of historical, sociological, literary, legal, and mass media sources, all designed to illuminate broader themes of class, gender, and race in social and cultural history. All students are welcome to take the course, whether or not they play the game of golf. However, if you think that St. Andrews is the Vatican's summer home; or that 6-under is Tony Soprano's 2010 business plan; or that a mashie niblick is a side dish at KFC, you may want to reconsider.

79-364 Art, Anthropology, and Empire

Intermittent: 9 units

This seminar will explore the anthropology and history of aesthetic objects, as they travel from places considered "primitive" or "exotic," to others deemed "civilized" or "Western." First, we will consider twentieth-century anthropological attempts to develop ways of appreciating and understanding objects from other cultures, and in the process to reconsider the meaning of such terms as "art" and "aesthetics." Then we will discuss several topics in the history of empire and the "exotic" arts, including: the conquest, colonization and appropriation of indigenous objects; the politics of display and the rise of museums and world fairs; the processes by which locally-produced art objects are transformed into commodities traded in international art markets; the effects of "exotic" art on such aesthetic movements as surrealism, etc.; and the appropriation of indigenous aesthetic styles by "Western" artists. Finally, we will consider attempts by formerly colonized populations to reclaim objects from museums, and to organize new museums, aesthetic styles, and forms of artistic production that challenge imperialism's persistent legacies.

79-367 Delinquency, Crime, and Juvenile Justice: The Modern Period, 1941 to the Present

Intermittent: 9 units

This course will examine juvenile delinquency in historical, sociocultural, and policy contexts since the beginning of World War II (1941 to the present), and will focus mainly on the United States. Readings will be drawn from historical, sociological, psychological, literary, and journalistic accounts of juvenile delinquency and the operations of the juvenile justice system. We will also analyze the treatment of delinquents as revealed in approximately a half-dozen films produced between the 1940s and 1990s (e.g., "West Side Story" and "Boyz n the Hood"). The course will be run in a seminar format; student initiative and participation in each class discussion are essential.

79-368 Poverty, Charity, and Welfare

Intermittent: 9 units

This course explores continuities and changes in ways that people have thought about and acted upon problems of human poverty. Although the major focus will be on Western Europe, students will have the opportunity to explore other societies and cultures. We discuss ways that poverty was conceived of and treated in medieval society; transformations in these views and policies during the Protestant and Catholic Reformations; the impacts of industrialization on the poor; and the development of modern welfare states. We ask such questions as: What have been the major causes of poverty? How did organized programs for the poor develop in the West? How have the poor been thought about and represented in art and literature? What have been the main differences between religiously inspired and secular programs of aid

to the poor? What accounts for the growth of "welfare states" in the twentieth century? Coursework includes readings from primary and secondary sources, participation in class discussions, inclass test, and a short research paper.

79-369 The World of Andrew Carnegie

Intermittent: Mini Session - 6 units

Carnegie Mellon University's founder Andrew Carnegie was both shaped by and shaped the world in which he lived. This mini provides students with an opportunity to explore Carnegie's world through biography. We will read the critical biography by Joseph Wall, Andrew Carnegie, as the central text and focus on the following specific themes in Carnegie's life and times, looking at their typicality or uniqueness in Carnegie's personal experience: 1) The British industrial revolution and the skilled textile trades (Carnegie's father was a skilled linen hand weaver), 2) Antebellum emigration to the U.S. and the immigrant experience in the Pittsburgh region, 3) Industrialization in the United States, 4) The rise of big business in the United States, 5) American labor history, and 6) The development of American philanthropy. Additional reading assignments will supplement the Wall biography. The course will also compare and contrast Andrew Carnegie's life and work with that of Carnegie Mellon University's other big name, Andrew Mellon, the home-grown younger contemporary of Carnegie's who often did not see eye-to-eye with the higher profile Scotsman.

79-370 History of Black American Music

Intermittent: 6 units

Come and explore the rich musical heritage of Black America. This course will survey the music of Black America beginning with the African legacy and continuing through the music of the Twentieth Century. Class sessions will involve discussions, listening, viewing of films, and reports by students on topics of individual interest. Discussions will involve, historical, cultural and political perspective, as well as the music and composers themselves. Lecturing will be at a minimum. Innovative testing in quiz show format will be used. No prerequisites required. Open to upper level undergraduate students.

79-371 Entrepreneurship, Regulation and Technological Change

Intermittent: 9 units

This course focuses on the interrelationships between public policy and technological change, with special emphasis on the role of entrepreneurship. Students develop a fundamental understanding of regulatory institutions, the evolution of the US regulatory state, and innovation and diffusion of new technologies in the context of the state, technological change, and competition policy. These concepts will be fleshed out using historical and contemporary case studies, including the information and communications industry, transportation industry, and energy industry, among others.

Prerequisites: 73251 or 79202 or 88202 or 88220

79-372 Photography, The First 100 Years, 1839-1939

Intermittent: 9 units

Photography was announced to the world almost simultaneously in 1839, first in France and then a few months later in England. Accurate "likenesses" of people were available to the masses, and soon reproducible images of faraway places were intriguing to all. This course will explore the earliest image-makers Daguerre and Fox Talbot, the Civil War photographs organized by Mathew Brady, the introduction in 1888 of the Kodak by George Eastman, the critically important social documentary photography of Jacob Riis (How the Other Half Lives: Studies Among the Tenements of New York) and his successor, Lewis Hine, the Photo-Secession of Alfred Stieglitz, the Harlem Renaissance of James VanDerZee, the precisionist f64 photographers Ansel Adams, Imogen Cunningham, and Edward Weston, and a host of other important photographers who came before World War II. The class will be introduced to 19th century processes, such as the daguerreotype, tintype, and ambrotype, as well as albumen prints, cyanotypes, and more. Two field trips will take place during class, one to Photo-Antiquities on Pittsburgh's North Side, and one to Silver Eye Center for Photography on Pittsburgh's historically designated Carson Street, on the South Side.

79-374 Europe and the Islamic World

Intermittent: 9 units

From Islamic conquest of Damascus to the modern-day "War on Terror," the path of European civilization has been intimately entwined with that of the Islamic world. But cooperation as well as conflict has characterized the historical interactions between Islam and Christian Europe. This class, therefore, will map out the complex winding road of Islamic-European contacts from the time of Mohammed to the modern era. Europe and the Islamic World is primarily designed to be an upper-level history course featuring frequent oral assignments, a heavy reading load, and numerous discussions of relevant primary and secondary texts.

79-379 Women in American History

Intermittent: 9 units

This course explores the history of women in the United States since the mid-eighteenth century. We will examine the sometimes common, but often divergent, experiences of women as they attempted to negotiate and improve their lives in changing historical circumstances. Our discussions will include the experiences of women of color as well as women from different classes and regions.

79-380 Experiencing Globalization

Intermittent: 9 units

The global marketing strategies of firms such as McDonald's and Coca-Cola... the use of offshore production plants and sweatshops by firms such as Nike and The Gap...the struggles over fair trade coffee... the rapid growth in international migration...new forms of "exotic" tourism ...the dramatic increase in material inequality around the globe. These are some of the most prominent symptoms of major changes that have been taking place in the working of the world since the late 1960s. Such changes are often referred to under the general heading of "globalization." How should we think about these changes? What is the relationship between their economic, political, and cultural dimensions? And, above all, how do people around the world experience them? We will explore these issues by focusing on the ways they are being addressed by socio-cultural anthropologists, historians of the present, documentary film-makers and others. We will consider the varied approaches these analysts employ. And we will explore how the challenges posed by globalization are encouraging them to re-conceptualize their objects of study and revise their modes of research. This course is meant to make it easier for you to recognize and engage the significant shifts that are taking place in the world around you, the relationships and processes that connect your daily lives to the lives of others elsewhere in the world, and the urgent contemporary debates about the current and future organization of these connections.

79-382 African-American Women in U.S. History

Intermittent: 9 units

This is an upper-level undergraduate course that focuses on African-American women's history from the era of slavery to the present. It will address broad themes such as labor, family, community, sexuality, religion, and popular culture. The course will examine the social, political, and economic diversity of the experiences of black women within the broader context of U.S. history. The course will enhance skills that are essential to studies in the humanities: critical thinking, writing, and oral communication. Course materials include primary and secondary sources, visual images, and films.

79-384 Medicine and Society

Intermittent: 9 units

This course examines the history of American medicine, public health, medical education, disease patterns, and patients' experiences of illness from the colonial period to the present. Students read the voices of historical actors, including physicians, patients, policy makers, and researchers. In analyzing these voices, students will learn what was at stake for different sets of actors as they confronted diseases and struggled to explain and cure them.

79-389 Topics in Anthropology

Intermittent: 9 units

This course will examine the cultures and societies of the Caribbean focusing on their colonial past, their current positioning in the world, their social structure, cultural patterns and current transnationalism. Using social history, film and music we will explore the topics of race, class, family, gender, religion, national identity and underdevelopment. Comparative research projects will provide concrete instances of the differences and similarities between the Anglo-Caribbean, Franco-Caribbean, and Hispanic Caribbean.

79-392 Dilemmas and Controversies in Anthropology

Intermittent: 9 units

Anthropology is poised at the intersection of art and science. Like scientists, anthropologists collect and analyze data, but it is data gained through relationships -- relationships forged with and by historically situated human beings in all their social and emotional complexity. In this course we will explore the practical and ethical dilemmas anthropologists confront in the field and in their writing. We will also investigate the nature of anthropological knowledge and investigate key controversies that have arisen in the discipline. Students are encouraged to think deeply and analytically about anthropology's strengths and limitations. Classroom debates will be a core component of the course.

Prerequisites:

79-393 Inward Odyssey

Intermittent: 9 units

Inward Odyssey explores world history by examining it through the outward-looking eyes of travel writers, on the assumption that travelogues, though supposedly written about the "other," in fact provide crucial insights about the mindset of the culture that produced them, and often serve as a vehicle for cultural self-exploration or even self-criticism. Overall the course has four primary goals: 1) to improve student critical reading skills, 2) to train students to historically contextualize documents, 3) to improve student analytical writing skills, and 4) to improve student understanding of our shared global history.

79-395 The Arts in Pittsburgh

Intermittent: 9 units

This course will examine the arts in Pittsburgh, both historically and in the present. We will focus especially on art exhibits and musical events scheduled by the city's museums and concert halls during the semester. The "curriculum" will derive from the artistic presentations themselves, which will provide a springboard for reading assignments, seminar discussions, and research papers in the history of music and art. We will also examine the historical development of cultural institutions in Pittsburgh. The History Department will pay for students' admission to all museums and studios. However, students will be charged a supplemental fee of a minimum of \$140 to help subsidize the considerable expense of purchasing tickets for concerts and performances by the Pittsburgh Symphony, Pittsburgh Opera, Chamber Music Society, and Renaissance and Baroque Society. Attendance at all art exhibits and musical events is required. Prerequisite: Availability to attend art exhibits on several Fridays and Saturdays, and to attend musical events on several Thursday, Friday and Saturday evenings.

79-396 Music and Society in 19th/20th Century Europe and the U.S.

Intermittent: 9 units

This course will explore the interrelations between society and classical and popular music in the nineteenth and twentieth centuries in Europe and the United States. We will examine the importance of different musical forms in the life of society and how music contributed to the making of political consciousness, especially in the twentieth century. In addition to reading assignments, seminar discussions, and research papers in the history of music, students will be taken to the performances of the Pittsburgh Symphony, Pittsburgh Opera, and Chamber Music Society. A supplemental fee of a minimum of \$140 will be charged to subsidize part of the considerable expense of purchasing tickets for concerts and performances. Prerequisite: Availability to attend musical events on several Thursday, Friday, and Saturday evenings.

79-397 Religion and Politics in the Middle East

Intermittent: 9 units

This course considers the nexus between government and religion in Islam, Judaism and Christianity and the historic relationship among these three religions in the political realm. We will study the influence of religion on both domestic and foreign policy in selected Middle Eastern countries, the role of religion in fueling conflicts, the phenomenon of religious fundamentalism, and the implications for US policy towards the region.

79-400 Advanced Studies in Anthropology and History

Fall: 12 units

More than a simple blending of fields, the joining of anthropology and history has engendered intellectual innovations in both disciplines. To better appreciate what the practitioners of these disciplines have to learn from each other, the first part of this course focuses on a key topic or theme and examines historical and anthropological work on this subject. This year the topic will be globalization. During the second part of the course, students will develop independent research projects related to this topic, in theory and in method. Student projects should bring both disciplines to bear on a particular problem of special interest. Research may be based on deep reading in the literature on a topic, on ethnographic fieldwork, on archival investigation, or on a combination of these methods. By undertaking this work, students will gain a better grasp of how new knowledge is created and of what transdisciplinary approaches have to contribute to understanding the world in which we live.

Prerequisites: 79200 and 79201 and 79209

79-404 Extreme Ethnography

Intermittent: 9 units

Observation, participation and direct experience of "the field" are hallmarks of anthropological ways of knowing, and their representation has played a foundational role in ethnographic writing both past and present. Yet reflexive and postmodernist explorations of these topics have triggered contentious debates over

the nature of anthropology as a scientific or humanistic enterprise, and over its ethical, political and epistemological value. In this seminar, we will approach such questions through an exploration of the extremes of ethnographic fieldwork and writing. We will consider such topics as: the colonial history and politics of explorers and ethnographers; liminality and the place of extreme experience--such as cultural dislocation, violence, derangement, intoxication, sex, possession, and dreaming-in fieldwork and writing; field-notes as an ethnographic genre, and their relationship to "official" published ethnography; ethnographic surrealism and surrealist ethnography; the dimensions of sensory experience (visual, auditory, olfactory, etc.) in fieldwork and ethnography; collecting and the powers of "exotic" objects; inter-subjectivity and its implications; and experimentation with alternate ethnographic forms, such as autobiography, film, diary, and poetry. **Please Note** students electing to take this class should have a background in anthropology.

79-409 History and Policy Project Course Mini

Spring: Mini Session - 6 units

Majors in History and Policy are required to take the History and Policy Project Course Mini in the spring semester of their junior year; no other students are eligible for this course. Students read background material relevant to the project to be undertaken in the fall, identify relevant archival materials, and refine the research questions, and make preliminary research plans.

Prerequisites: 79200 and 79202 and 79208

79-410 History and Policy Project Course

Fall: 12 units

The History and Policy Project Course is required for the History and Policy major and is taken in the fall semester of the senior year. In this capstone course, History and Policy majors carry out a collaborative research project which examines a compelling current policy issue which can be illuminated with historical research and analysis. Based both on archival research and on contemporary policy analysis, the students develop an original research report and presentation for a client organization in the community.

Prerequisites: 79200 and 79202 and 79208 and 79409

79-420 Advanced Studies in Social and Cultural History

Fall: 12 units

This course will focus on a theme, concept, or category that has been central to the historical investigation of society and culture in a variety of places and times. Colloquium topics may include social groups and classes (peasants, workers), social institutions (family, state), socio-cultural identities (ethnicity, religion), political-cultural identities (nationalism), or socio-economic development (agriculture, industrialization). Examining its chosen theme from a variety of angles, the course will consider how historians of different regions have applied key theoretical approaches and definitions. Students will also engage in an independent research project on the course topic. This course is designed for advanced history majors.

Prerequisites: 79200

79-421 Social and Cultural History Research Seminar

Intermittent: 9 units

This is a small seminar course focused on advanced readings in social history, particularly from a comparative perspective.

79-440 Perspectives on Industrial Research and Development

Intermittent: 9 units

Incandescent and fluorescent electric lights; nylon and Kevlar®, the atomic bomb; the transistor and integrated circuits; Post-it® notes; Teflon®; Silly Putty®; GameBoys®; and biopharmaceuticals (from Viagra® and Levitra® to Paxil® and Enbrel®), among a panoply of other consumer and industrial goods, are all products that emerged from organized industrial research and development (R&D) programs. The beginnings of this new institution in the late 19th century, its rapid rise in the first third of the 20th century, its flourishing in the middle third of the 20th century, and its decline and reorganization in the last decades of the 20th century and first decade of the 21st century are the principal focus of this advanced reading seminar. What factors led to the establishment of modern R&D? Why did industrial R&D laboratories appear in the United States and other industrialized nations? How did their creation change the character of science, technology, and business? How did the institutionalization of R&D affect the work of individual inventors, engineers, and scientists? Does big business now dominate R&D in the United States, or does "the little guy" (including university-based "start ups") still play an important role in technological innovation? What about the interaction of universities and industrial R&D programs? How has industrial R&D been "managed"? How has federal science and technology policy affected industrial R&D? With the globalization of business, is industrial R&D

also becoming global, and if so, how does industrial R&D work on a global scale? Why did the last decade of the 20th century see the decline or disappearance of numerous prestigious industrial research organizations? What is the future of industrial R&D in the 21st century? These are some of the questions explored in this course, which is open to serious students from all colleges.

79-441 Science, Technology, and Business in U.S. History
Intermittent: 9 units

This reading seminar focuses on the history of science, technology, and business in the United States from the American Revolution to the late twentieth century. Although the course follows a rough chronology, it treats in depth several major topics and themes that are well developed in the historical literature.

79-491 Independent Study

All Semesters: 3-18 units

An Independent Study is meant for students with a special interest in an area not covered by a formal history course. Readings and other work are negotiated between the student and an individual faculty member.

79-503 Senior Thesis I

Fall: 9 units

Seniors may write a thesis with permission of the Undergraduate Advisor and a designated faculty member who will supervise its completion.

79-504 Senior Thesis II

Spring: 9 units

Seniors may write a thesis with permission of the Undergraduate Advisor and a designated faculty member who will supervise its completion.

79-505 Undergraduate Internship

All Semesters: 3-12 units

Interns may be placed in relevant off-campus positions where they are evaluated by both an on-the-job supervisor and a faculty member. Permission of the department's Director of Undergraduate Studies is required.

Philosophy

80-100 Introduction to Philosophy

All Semesters: 9 units

In this introductory course we will explore three major areas of Philosophy: Ethics, Metaphysics, and Epistemology. Accordingly the course is divided into three sections. In each section we will read primary sources and discuss some of the main philosophic problems associated with that area. These will include: moral problems (Ethics), problems arising from the debates about free-will, personal identity or intelligence (Metaphysics), and inquiries about the scope and limits of human knowledge (Epistemology). We will then introduce some theories designed to solve such problems, and try to understand the strengths and weaknesses of these theories. We will apply different techniques and theories to issues that we might encounter in the real world. We will use class discussions, homeworks and papers to learn skills for evaluating arguments. These skills include: how to present a philosophic argument, what are the assumptions that justify it, what are its weaknesses and its strengths, whether such weaknesses can be resolved and, if they cannot be resolved, why.

80-101 Freshman Seminar: Mathematical Context

Fall: 9 units

This course explores historical, scientific, and philosophical contexts in which mathematics is developed, and the ways in which mathematics enables us to obtain precise descriptions of various aspects of human experience. Topics include the development of non-Euclidean geometry and Riemann's theories of manifolds with applications in cosmology, and the theory of computability with applications in cognitive psychology. Students will become familiar with fundamental set theoretic notions, as well as Turing machines and cellular automata.

80-102 Honors Program in What is Philosophy

Fall and Spring: Mini Session - 3 units

This three credits extension of 80-100 is open to Freshmen and Sophomores by invitation of their instructor only. The seminar meetings examine interesting puzzles and open controversies concerning topics raised in 80-100.

80-103 Freshman Seminar: Voting Theory

Spring: 9 units

The class will study some basic voting theory, including issues of constitutional design, voting paradoxes, and spatial models of candidates' and voters' strategic behaviors. We will use A. Downs's classic, 1957 book, *An Economic Theory of Democracy* as our principal text. Relating to our theoretical inquiry, we will examine several ways in which the Internet functions during the run-up to the 2004 US Presidential campaign. For example: • How does the Internet serve as a medium for communicating with, and among voters and monitoring their opinions as part of strategies the candidates might employ? • Do the candidates' evolving positions, as tracked on their homepages, conform to the strategies that Downs' theory entail?

80-110 Nature Mathematical Reasoning

Spring: 9 units

This course focuses on understanding mathematical reasoning, not on mastering a particular mathematical theory like linear algebra or calculus. It explores instances of mathematical reasoning and rigorous argumentation, with examples from the history of science and mathematics. We consider the "Lets Make a Deal" puzzle, the counter-intuitive results of HIV testing, and how to assess the relative size of infinite sets, all problems which defy intuitive solution but which look simple after they are put in mathematical form. The course is designed for students at the freshman and sophomore levels who are not interested in a mathematically intense major.

80-130 Introduction to Ethics

Spring: 9 units

This course provides both a historic and thematic survey of western ethical theory. Key figures such as Aristotle, Hobbes, Kant, Mill, and Nietzsche will be presented as background to the thematic problems of relativism, egoism, and other concepts in ethical theory. Students will take part in the creative process of developing skills necessary to engage in reflective moral reasoning. This process will culminate in the use of interactive multimedia modules simulating real world scenarios involving difficult moral choices. Participating in a class ethics committee will provide students with opportunities for personal reflection on the ways moral reasoning can be used to expand our understanding of hard choices and moral dilemmas.

80-135 Introduction to Political Philosophy

Fall: 9 units

As an introductory course, we will seek to trace out the historical and philosophical dimensions of the polis from its origins in Ancient Greece to its current manifestation in present-day society. Special emphasis will be placed on the concept of "democracy." The readings and lectures will focus on the history and concept of democracy (as an idea and as an institution); the basic concepts and problems of political philosophy (e.g., liberal and libertarian ideas of justice); and applied political philosophy (e.g., regional initiatives in deliberative democracy).

80-136 Social Structure, Public Policy & Ethics

Fall: 9 units

The course will consider ethical questions that arise regarding social structure and public policy's impact on both people and the environment. It will consider the role of political institutions (and, sometimes, individuals) in dealing with some of the greatest challenges facing our generation: World poverty, environmental problems, and globalization. Some of the questions we will consider include: Are developed countries like ours obligated to ameliorate poverty by providing foreign aid, are they obligated to prevent environmental problems, and is globalization and free trade in particular a good idea? The course uses theory, case studies, and empirical evidence to consider these questions from a few different moral and political perspectives. We will extract some economic principles and rational dilemmas from examining these issues and pay attention to how legal and empirical considerations interact with ethical considerations.

80-150 Nature of Reason

Fall: 9 units

This course offers an intellectual history of philosophical views regarding the nature of human reasoning in mathematics and the sciences, from ancient to modern times. The first part of the course traces the search for deductive methods for obtaining certain knowledge, starting with Aristotle and Euclid, and continuing through the Middle Ages and late Renaissance thought, to the work of Boole and Frege in the nineteenth century. The second part of the course considers the history of skepticism about empirical knowledge, covering Plato, Sextus Empiricus, Descartes, Pascal, and Hume, along with replies to skepticism in the works of Bayes and

Kant. The third part of the course discusses theories of the nature of mind, culminating in the computational conception of mind that underlies contemporary cognitive science.

80-151 God in the West

Fall: 9 units

This course surveys the rise of Christianity from pagan and Jewish sources, the rise of Islam, the fragmentation of the two religious movements, and their confrontation over a millennium and a half. The course will focus on several questions and themes: Why and how did Christianity succeed in converting the Roman Empire? Why and how did Islam succeed in converting more than a billion people? How did doctrine and practice become transformed by institutionalization and circumstance? How and why did the two movements respectively fragment? How and why did secularization occur? What is "fundamentalism" and why does it endure? Ethical and doctrinal issues will also be considered, in some cases at length.

80-180 The Nature of Language

Fall and Spring: 9 units

Linguistics is the scientific study of human language. It comprises many sub-fields, in which the different aspects of language are investigated. The topics studied in linguistics range from the mechanisms of human speech production to the nature of linguistic meaning, from historical relations among languages to current linguistic change, from writing systems to abstract linguistic structure. This course will provide a broad introduction to the field of linguistics, surveying a number of the major sub-fields. The focus of the course is not on describing or analyzing one particular language, but on understanding the properties and nature of language as a human phenomenon.

80-195 Research Training

Fall and Spring: 9 units

This course is part of a set of 100-level courses offered by H&SS departments as independent studies for students in the College. In general, these courses are designed to give students some real research experience through work on a faculty project or lab in ways that might stimulate and nurture subsequent interest in research participation. Faculty and students devise a personal and regularized meeting and task schedule. Each Research Training course is worth 9 units, which generally means a minimum for students of about 9 work-hours per week. These courses are offered only as electives; i.e., they cannot be applied toward a college or major requirement, although the units do count toward graduation as elective units. Additional details (including a roster and descriptions of Research Training Courses available in any given semester) are available in the H&SS Academic Advisory Center. For H&SS students only; only for second-semester freshmen, or first- or second-semester sophomores; minimum cumulative QPA of 3.0 (at the time of registration) required for approved entry; additional prerequisites (e.g., language proficiency) may arise out of the particular demands of the research project in question.

80-201 Epistemology

Fall: 9 units

Epistemology, one of the cornerstones of philosophy since ancient times, concerns the relationships between belief, truth, and knowledge. This course will explore fundamental issues in epistemology, such as the analysis of the concept of knowledge, epistemic justification and scientific method, a priori knowledge, theories of truth, skepticism, reliabilism, and coherentism. Both classic texts and contemporary journal articles will be discussed. There are no prerequisites, but students with some philosophical sophistication and/or formal ability will be more comfortable with the material.

80-208 Critical Thinking

Spring: 9 units

This course is an introduction to practical reasoning. The course will contain an elementary introduction to concepts important for reasoning and decision making, such as validity, probability, and utilities. Students will extensively practice critically analyzing and evaluating a wide variety of arguments found in newspapers, magazines, and elementary accounts of scientific reasoning. In order to help students develop the skills to analyze and evaluate arguments, the course will introduce several software packages recently developed at CMU that help students diagram arguments and causal reasoning; these packages have been shown to improve students' critical reasoning skills. In addition, students will learn about a wide variety of statistical, logical, psychological, and causal fallacies that are used to mislead people.

80-210 Logic and Proofs

All Semesters: 9 units

This web-based course introduces students to central issues in logic and develops their ability for constructing and refuting arguments. It addresses the question: How can one analyze the structure of rational discourse or, more specifically, the logical structure of argumentation? An answer to this question requires: (i) uncovering the logical form of statements; (ii) defining the correctness of logical steps; (iii) formulating inference rules for the logical forms; (iv) designing strategies for argumentation with the inference rules. The course takes these steps for both sentential and quantificational logic. Presentation: The material is presented on-line, though some exercises must be done with pen and paper. Additional reading of historical and philosophical character complements the systematic on-line presentation. Weekly small discussion meetings with collaborative reviews, substantive discussions and critical reflections supplement the on-line material.

80-211 Logic and Mathematical Inquiry

Spring: 9 units

Since ancient times, those searching for truth have looked to mathematical arguments as a paradigm of rational inquiry. We study the structure of such arguments and their application. In the first half of the course, we develop the syntax and semantics of sentential and quantificational logic while in the second, we apply this logic to examine the axiomatic method in set theory and introduce formal models of computation. This course prepares students to take the 310-311 series on the fundamental (in)completeness and (un)decidability theorems of modern logic.

80-220 Philosophy of Science

Fall: 9 units

In this course, we will examine some historical case studies (e.g., the Copernican revolution in astronomy) against which we will assess views pertaining to the significance, justification, and production of scientific knowledge. For example, should scientific theories be understood literally or as computational devices for deriving new predictions? How can universal conclusions ever be justified by a finite data set? Does explanation contribute to a theory's confirmation by the evidence? Does science aim to find the truth? Is probability in the world or only in our minds? Is explanation a matter of finding causes or are causes whatever it is that explains? Is scientific rationality objective or culture-relative?

80-221 Philosophy of Social Science

Fall: 9 units

Can we use the scientific method to understand social phenomena like war and religion in the same way that we use it to understand natural phenomena like lasers and microchips. For example, humans possess free will and act with intentions while light rays do not; does this mean we must use different species of explanations in the two cases? Do simple social 'laws' exist which explain basic social norms like cooperation? Do social norms evolve in the same way as do biological species? Is our understanding of social phenomena always value laden?

80-222 Measurement and Methodology

Spring: 9 units

This is intended as an introduction to the theory of measurement. How are units chosen? Under what conditions do qualitative relationships determine quantitative ones? We shall investigate theories of extensive measurement, with and without error. Applications will be taken from the natural and social sciences. Prerequisites: None specifically; however, students should have background in elementary logic and be comfortable with taking mathematical approaches to conceptual problems.

80-226 Revolutions in Science

Fall: 9 units

Contemporary science emerged from a series of revolutionary innovations in scientific theory and scientific method. Starting with the Newtonian revolution of the 17th century, this course will consider the scientific, philosophical and human issues in several revolutionary scientific episodes, with lectures providing background and linkages. Besides the Newtonian revolution, topics may include: Antoine Lavoisier and the establishment of experimental chemistry; John Dalton and the development of the atomic theory; Michael Faraday and James Maxwell and the theory of electromagnetism; evolution and genetics from Charles Darwin to Gregor Mendel and after; comets, hereditary genius, and the creation of statistics; the testing of the General Theory of Relativity as seen through the eyes of the woman who saved Einstein's theory from refutation; Alan Turing and the creation of the digital computer and the theory of computation. Students will work with some of the original historical data.

80-230 Ethical Theory

Spring: 9 units

Every day, often in very subtle ways, we make judgments of value that shape our lives and our conduct. This course provides a systematic examination of foundational concepts in ethics and the comprehensive theories that explain their importance and their relationship to one another. We will therefore examine alternative treatments of concepts such as welfare and happiness, basic moral rights, and different moral virtues. We will also analyze the role of these conceptions in different foundational moral theories such as utilitarian approaches, Kantian theories, Aristotelian ethics, contractarian moral theories, and possibly others as well. Primary readings will focus on source texts by Aristotle, Hobbes, Kant, and Mill along with secondary readings from more contemporary sources. Particular attention will be paid to locating specific areas of disagreement that distinguish competing moral theories so that we can evaluate them on a reasoned basis and make an informed decision about their respective merits and deficiencies.

80-235 Political Philosophy

Spring: 9 units

At the heart of political philosophy lie fundamental questions such as: What constitutes a just society? How, and under what circumstances do individuals incur special political obligations to a particular state? What are the limits of the legitimate authority of the state and how are they defined? This course provides a systematic investigation of the way these questions are answered by dominant schools of liberal political theory, such as the social contract tradition, utilitarianism and libertarianism. Because the liberal political tradition is also strongly egalitarian in nature, the course will examine different conceptions of political equality and conflicting views about the respects in which community members may have a just claim to equal treatment. This course also examines important critiques of this tradition from Marxist, communitarian, and feminist standpoints. Readings are drawn from classic works by Hobbes, Locke, Kant, and Mill, and from the works of contemporary theorists like Rawls, Nozick and others.

80-241 Ethical Judgments in Professional Life

Fall: 9 units

This is a multimedia, hybrid course that examines the numerous ethical issues, problems and dilemmas that confront professionals in such areas as medicine, law, engineering, the media, government and the natural and social sciences. As a hybrid course, it includes educational materials in video streaming format, an audio CD, an electronic discussion board and web-based "guided inquiries" that students navigate and complete. Topics discussed include: Responsibility in the professions, obligations to clients, conflicts of interest, Whistleblowing, codes of ethics and ethics in engineering, medicine, law, media, computer science and business among others. This course meets one day a week and employs a case study discussion format during class.

80-242 Conflict and Dispute Resolution

Fall and Spring: 9 units

Are you willing to challenge your pre-conceived notions about yourself and others regarding conflict? Recognizing the influence of gender and culture, and using Needs, Power and Conflict Style theories, along with other concepts, this course requires you to examine and understand different ways to engage in or avoid conflict. Your learning process will be enhanced with the use of self-assessment tools including Myers-Briggs and the Intercultural Conflict Style Inventory. These and other self-assessments are integral to understanding that conflict is influenced by individual preferences. In addition to lectures and discussions, in-class activities will include role-plays, negotiation games, and analysis of real-life conflicts. As the semester progresses, your and your classmates' areas of interest will be incorporated into the course materials. Because each student brings a wealth of knowledge and experience regarding conflict, there are no prerequisites.

80-243 Business Ethics

Intermittent: 9 units

Various moral mazes that confront managers in the contemporary business organization will be the focus of this course. Topics treated will include: conflicts of interest, whistleblowing, confidentiality and privacy, environmental issues, sexual harassment, diversity in the workplace, international business ethics and corporate social responsibility. Codes of business ethics, ethics audits, recommendations from the U.S. Sentencing Guidelines Commission, the Sarbanes-Oxley Act, ethics hotlines, business ethics officers, corporate ethics committees and other mechanisms designed to address the ethics of business will also be examined.

80-244 Environmental Ethics

Fall: 9 units

The aim of the course is to provide students with an introduction to environmental ethics. The course will cover topics that should help us assess what the best relationship between humans and the rest of the natural world should be. Issues that the course may consider include animal rights, consumption, overpopulation, global warming, trade-offs between saving some parts of nature and others, and how we should think about environmental protection in developing countries.

80-245 Medical Ethics

Fall: 9 units

This course provides an introduction to core ethical issues in health care, medical research, and public policy. Topics include: the moral responsibilities of health care providers to patients and various third parties such as the government or insurance companies, the status of health as a social good, and questions of individual liberty and social responsibility at the ends of life including issues such as abortion, physician assisted suicide, and the definition of death. We will also examine specific ethical issues in the conduct of medical research and look at the impact of technological innovation on our notions of health, disease, life, death, and the family. If time permits, we may also discuss issues related to genetics and cloning. While the course engages such substantive ethical issues it also attempts to sharpen students' skills in practical reasoning through argument analysis, analogical reasoning, and the application of theory and principles to particular cases.

80-247

Spring: 9 units

Health, Development, and Human Rights: Approximately 1.1 billion people world wide live on less than \$1 a day in a condition the World Bank refers to as extreme poverty. Those who live in extreme poverty frequently lack effective access to proper nutrition, adequate shelter, safe drinking water, and sanitation. As a result, they also bear the greatest burdens of famine and epidemic disease and frequently face social and political conditions of unrest and systematic oppression. This course examines the question of what, if anything, we in the technologically and economically developed world owe to the global poor. It therefore focuses considerable attention on competing theories of global distributive justice and the relationship between poverty, poor health, and human rights. We will critically examine different strategies for international development that emphasize one or more of these variables and we will consider how information about the complex interrelationship of these variables should be factored into the development process. In addition, we will examine different metrics that have been proposed for measuring the welfare and developmental status of different communities focusing particular attention on the theories of wellbeing that they presuppose.

80-250 Ancient Philosophy

Fall: 9 units

This course provides a broad survey of Ancient Greek philosophy from the pre-Socratics, through Socrates, Plato, and Aristotle, to the later Hellenistic writers. Through careful study of primary texts we will explore some of the historical and intellectual movements that led up to and culminated in the flourishing and downfall of Periclean Athens. A study of Socrates (as represented in Plato's early dialogues) will lead to an in-depth reading of Plato's *Phaedo*, *Meno*, and sections of the *Republic*. We will then explore Aristotle's systematization of philosophy through selections from the *Metaphysics*, *De Anima*, and the *Nicomachean Ethics*. The course will conclude with an examination of Epicurean and Stoic movements from the Hellenistic period. This course provides a strong foundation in the history of philosophy, and the history of western moral, political, metaphysical, epistemological, and psychological thought more generally.

80-251 Modern Philosophy

Fall: 9 units

Descartes' project to doubt all received knowledge and begin from scratch marked the beginning of an intellectual upheaval, helping to launch what is now called the Modern period of philosophical thought; the Western world is today the heir of modernism. Locke, Leibniz, Hume, and Kant are several of the most important figures of this period. We will examine works of these thinkers, exploring both the new sorts of questions that these philosophers raised and their new methods of doing philosophy, which together mark a fundamental break with the traditions that preceded them. We will devote special attention to the new theories of knowledge they proposed. The philosophical revolution of the 17th and 18th centuries occurred during a time of great scientific progress and political upheaval in Europe; as part of our course we will consider

the relation of certain of these developments to the new questions and methods of the modern philosophers.

80-252 Kant

Spring: 9 units

Immanuel Kant's 'Critical philosophy' may be seen as the result of his attempts to determine the sources of human knowledge, and to find metaphysical foundations for Newton's mechanics. This course will involve readings in Kant's /Critique of Pure Reason/ and other texts. Emphasis will be placed on understanding Kant's thought in the context of contemporary intellectual developments and on his theory of human cognition.

80-253 Continental Philosophy

Spring: 9 units

This course provides students with an overview of key historical and philosophical movements in European Philosophy. The cultural and historical background for 20th Century Continental Philosophy covers Descartes, Kant, Kierkegaard, and Nietzsche (Hegel and Marx are also options). Early to mid-20th Century Continental Philosophy covers the central tenets of phenomenology and existentialism (e.g., intentionality, Being-in-the-World, Bad Faith). This part will involve selections from the works of, for example, Husserl, Heidegger, Sartre and Merleau-Ponty. Finally, cultural and philosophical trends such as Structuralism, Hermeneutics and Post-modernism (e.g., Derrida, Foucault, Lyotard and Habermas) will be addressed.

80-254 Analytic Philosophy

Spring: 9 units

This course examines the revolutionary impact on philosophy and contemporary thought of several scientific breakthroughs that occurred at the turn of the 20th century. By the 1920s some scientists and philosophers became hopeful that the end of the long tradition of philosophical deadlock was finally within reach. Buoyed in particular by Einstein's theory of relativity and the invention of modern logic, they created a new kind of scientific philosophy with the goal of applying logical and empirical methods to philosophical problems. The new movement became a major intellectual force until its disruption by the Second World War. From Wittgenstein's language-oriented philosophy to the scientific study of such notions as meaning, information, computation, and inference, the modern fields of linguistics, cognitive science, and information and computer sciences all owe a debt to these sources, as does of course contemporary philosophy. This course will be centered around selected readings of Frege, Russell, Wittgenstein, and the Vienna Circle, as well as the post-war reception by Quine and others.

80-255 Pragmatism

Fall: 9 units

American Pragmatism represents an energetic attempt to bridge the divergent cultures of science and the humanities. The movement's founder, C.S. Peirce, was trained in chemistry and worked as a physicist, but he was also deeply concerned with the contemporary philosophical portrayal of science, which distinguished sharply between theoretical knowledge and practice. Peirce responded by constructing a comprehensive philosophy emphasizing the scientific importance of community, fallibility, and action. Pragmatism was also developed and vigorously popularized by William James, who aspired to be a painter and ended up as an acknowledged founder of modern empirical psychology. James extended Peirce's position by defending the role of values in even the purest of empirical sciences. John Dewey, who is also well-known for his role in education, interpreted science as an evolving social system and developed a theory of aesthetics based on what we now call the psychology of problem solving. The pragmatists made and continue to make lasting contributions to modern statistics, logic, and social science and their emphases on community, fallibility, action, and value in science are still of primary importance in philosophy and in the ongoing dialogue between the scientific and humanistic cultures.

80-256 Modern Moral Philosophy

Fall: 9 units

This course will address some of the central aesthetic theories concerning the nature of our judgments of the beautiful and of the sublime that were developed around the 18th century. The famous divide between the British empiricist philosophers and the rationalist philosophers of the Continent regarding the sources of human knowledge, was paralleled in a dispute regarding the nature of aesthetic judgments. In this course we will study the aesthetic theories of some of the most important figures of this period, with an emphasis on the work of Immanuel Kant.

80-257 Nietzsche

Spring: 9 units

During his life in the late 19th-century, Friedrich Nietzsche was a relatively obscure German philosopher. Since his death, however, he has become deeply influential and well-known, and was a source of inspiration for many important 20th-century thinkers. Despite this popularity, Nietzsche's philosophy remains relatively mysterious, and often misunderstood. Much of his writing consisted of aphorisms, rather than more traditional prose and arguments, and many of his positions seem to contradict one another. This course will cover a broad range of Nietzsche's writings, focusing on such central concepts as the will to power, eternal recurrence, and the oft-misunderstood *Übermensch* ("overman"). Throughout, we will focus on developing a consistent interpretation of an enigmatic philosopher whose views have been mischaracterized and misappropriated throughout the past century.

80-258 Leibniz, Locke, and Hume

Spring: 9 units

The course will take a close look at the theories of knowledge of three major thinkers of the 17th and 18th centuries: John Locke, Gottfried Wilhelm Leibniz, and David Hume. Selections from Locke's *An Essay Concerning Human Understanding*, Leibniz's reply in *New Essays on Human Understanding*, and Hume's views in the *An Enquiry concerning Human Understanding*, as well as other texts, will be discussed.

80-261 Empiricism and Rationalism

Intermittent: 9 units

A central issue in Western philosophy has been whether reason or experience (or some of both?) lies at the foundation of human knowledge, and the 17th and 18th centuries are a defining period of European history because they contribute the basic model of science and the ideals of intellectual and political enlightenment that are still dominant today. Specifically, we will focus on the problems encountered in trying to give an adequate account of the nature of the external world, the structure of our minds, and the nature and limitations of knowledge in the thought of Descartes, Locke, Leibniz, Berkeley, and Hume. The course has two main goals: (1) to study the metaphysical and epistemological theories of selected philosophers, paying close attention to the arguments offered on behalf of often very strange positions, and (2) to help you improve your analytical and critical skills, including, for example, extracting and evaluating philosophical arguments.

80-262 Introduction to the Philosophy of Bertrand Russell

Intermittent: 9 units

Near the start of the 20th Century, Bertrand Russell helped to create what today we call "Analytic Philosophy." We will study Russell's contributions to this important approach to Philosophy by using his 1912 book, "The Problems of Philosophy" as a springboard to other readings. The issues we'll cover include several specific challenges in the Theory of Knowledge and Perception. For example, What is the difference between appearance and reality, and can we tell? Also, we'll consider issues that stem from reflecting on our thinking. For example, What constitutes a philosophical question?

80-270 Philosophy of Mind

Fall: 9 units

Is the real nature of mental states? (the ontological problem); What sort of property (if any) confers truth evaluability and content on certain psychological states? (the semantical problem); How do we know that other agents have consciousness and enjoy mental states at all? What are the minimal conditions of personhood? (the epistemological problem); What sort of data is admissible to construct a 'science of the mind'? What are the relationships between 'folk' and scientific psychology? (the methodological problem); Which is the role of contentful psychological states in the explanation of behavior? How the intentionality and thought of individual agents connect with their social nature and their communal experience? (the problem of psychological explanation). Each year the course pays particular attention to a topic or a family of topics. In the recent years focal points have been: (a) recent theories of consciousness, (b) the status of the so-called computational theory of mind (alias functionalism), (c) the tension between computational and associationist models of the mind (d) the nature of desires and emotions.

80-271 Philosophy and Psychology

Spring: 9 units

Throughout both of their histories, philosophy and psychology have had a close relationship. This course will examine some of the many ways in which philosophical and psychological theories have mattered for each other, both in the past and present. For example, what does it mean (philosophically) to be rational, and

to what extent are we (psychologically) rational? To what extent are our minds evolved (and could we ever know), and how is (or ought) the methodology of psychology changed by a focus on evolutionary pressures? How have philosophical theories historically affected psychological theories (e.g., Kant's influence on Helmholtz's psychological theories), and vice versa? What are the psychological and neuroscientific foundations of our experiences of free will, and how (if at all) are they relevant to the philosophical problem of free will?

80-275 Metaphysics

Spring: 9 units

The topical agenda of this course will vary. Typical topics include the problem of personal identity, the nature of human freedom, the nature of the self, the nature of reality and being, the nature of causality, and the question of whether solutions to such problems can be given. Classical as well as contemporary philosophic texts will be studied.

80-276 Philosophy of Religion

Spring: 9 units

In order to expand our ideas about what religion could be, the course begins with a brief cross-cultural review of some major religious traditions around the world. Then we turn to some more traditional arguments for and against theism, including the ontological, cosmological, and design arguments, the argument from religious experience, the argument from miracles and historical testimony, and the problem of evil. We will also consider whether morality ultimately depends on God's sanctions and (yes, here it is at Carnegie Mellon) whether life would be meaningless if God did not exist.

80-280 Linguistic Analysis

Fall: 9 units

The goal of this course is to equip students with the vocabulary and skills needed to engage in the analysis of linguistic data. The course will focus on one or more of the following topics: syntactic analysis (analysis of sentence structure), phonological analysis (analysis of linguistic sound systems) or semantic analysis (analysis of sentence interpretation). Other topics may be included. In this course, you will develop your ability to describe linguistic phenomena accurately, to make linguistic generalizations, and to propose accounts of these generalizations within a given theoretical framework.

Prerequisites: 80180

80-281 Language and Thought

Spring: 9 units

The course addresses issues related to the connections between thought and language, particularly the ways in which we express thoughts and attitudes through language. Is language necessary for thought? What are the referents of linguistic expressions: cognitive or mental entities of some sort, or things out there in the world? Does the meaning of sentences come before their truth conditions, or the truth conditions of an expression are sufficient to determine its meaning? What kind of knowledge makes it possible for speakers of a language to communicate with one another? Is the meaning of expressions determined by norms and social conventions? What is a metaphor? What exactly serves as the context of an utterance in discourse? Do speakers of different languages perceive the world differently because of their language differences? The first part of the course addresses classical philosophical issues concerning the relation of truth and meaning, as well as issues related to the meaning of verbs of propositional attitude and pragmatics. The second part of the course focuses on more recent proposals in cognitive semantics, particularly theories that utilize conceptual spaces as the main framework to represent semantic information. We will also consider 'hybrid' theories that describe the form-meaning relation as an idealized account of the process whereby the recipient of an utterance comes to grasp the thoughts that the utterance contains. A basic course in logic is recommended but not required.

80-291 Issues in Multimedia Authoring

Fall: 9 units

This course emphasizes the philosophical, cultural, and sociological aspects of multimedia. The course will explore these issues historically and thematically by looking at central figures in the early days of computers and communication theory (e.g., Alan Turing and Claude Shannon) and recent work by writers such as Brenda Laurel (Computers as Theatre), George Landow (HyperText 2.0), and Janet Murray (Hamlet on the Holodeck: The Future of Narrative in Cyberspace). This is not a technical course in issues relating to the creation of multimedia software. It is a course concerned with the meaning of multimedia authoring in its contemporary societal context.

80-300 Minds Machines, and Knowledge

Fall: 9 units

We examine important presuppositions in several contemporary essays that debate the scope and limits of artificial intelligence. Specifically, the class discusses contemporary views on foundational versus coherence models of human knowledge. (Does human knowledge have a secure basis or is it a mere "web of beliefs"?) These questions about the organization of knowledge are contrasted with objections raised, for example, by Searle and Dreyfus against the "strong AI" thesis of Newell and Simon. Also, we consider several current models of knowledge which incorporate probability and other measures of uncertainty, including some recent work on "parallel" systems. Pre-requisites: 80-100 or some other intro level Philosophy course.

Prerequisites: 80100

80-305 Rational Choice

Fall: 9 units

This course will cover selected topics in rational choice theory, which informally is the analysis of how to make correct decision in a given context. The course offers an introduction to the main normative theories of rational choice: von Neumann-Morgenstern theory of expected utility, Anscombe-Aumann's account and Savage's theory of choice under uncertainty. Possible topics may include, and are not limited to: individual choice under uncertainty and related issues in the psychology of judgment and decision making, problems of public choice in which a group of individuals must collectively make a decision, game-theoretic problems of conflict and coordination, alternative approaches to the problem of fair division of goods as well as recent theories that abandon the Bayesian assumption that the decision maker's beliefs can always be represented by a unique probability distribution. This course will stress the role that formal methods can play in the analysis of decisions and alternative applications of decision theory to issues in philosophy and social science.

80-306 Meaning in Language

Spring: 9 units

This course provides a survey of the different ways in which meaning is conveyed in spoken languages, and of the different types of meaning which are conveyed. Topics to be covered will include: word meaning (lexical semantics); structure and meaning (compositional semantics); information structure (foregrounding and backgrounding); verb argument structure and thematic roles; intonational meaning and focus; presupposition; context dependency; discourse markers and utterance modifiers; and the role of inference in interpretation. The topics to be addressed bring together a variety of fields: linguistics; philosophy of language; communication studies and rhetoric; and language technologies. The course may be taken as either a 9-unit (80-306) or 12-unit (80-606/11-725) course. The 12-unit course will include an additional component, which will relate the content of the course to issues in computational linguistics, with an emphasis on methods of implementation. (The computational component will be taught by faculty from the Language Technologies Institute.) If there is adequate interest, an alternative additional component focusing on linguistic and philosophical literature may be available. Prerequisites: 11521 or 11721 or 76385 or 76386 or 76387 or 76389 or 76451 or 80180 or 80280 or 80380 or 82280 or 82383 or 85421

80-310 Logic and Computation

Fall: 9 units

Among the most significant developments in modern logic is the formal analysis of the notions of provability and logical consequence for the logic of relations and quantification, known as first-order logic. These notions are related by the soundness and completeness theorems: a logical formula is provable if and only if it is true under every interpretation. This course provides a formal specification of the syntax and semantics of first-order logic and then proves the soundness and completeness theorems. Other topics may include: basic model theory, intuitionistic, modal, and higher-order logics. Prerequisites: 15251 or 80210 or 80211 or 80212

80-311 Computability and Incompleteness

Spring: 9 units

The 1930's witnessed two revolutionary developments in mathematical logic: first, Gödel's famous incompleteness theorems, which demonstrate the limitations of formal mathematical reasoning, and second, the formal analysis of the notion of computation in the work of Turing, Gödel, Herbrand, Church, Post, Kleene, and others, together with Turing's results on the limits of computation. This course will cover these developments, and related results in logic and the theory of computability. Prerequisites: 15251 or 21300 or 80210 or 80211 or 80310

80-312 Philosophy of Mathematics

Spring: 9 units

The 20th century witnessed remarkable and novel developments of mathematics - with deep roots in the 19th century. The beginnings of these developments were beset with foundational problems and provoked a variety of programmatic responses: logicism, intuitionism, and finitism. For a deeper study of basic issues, we review a part of classical Greek mathematics (the theory of proportions) that is closely connected to the foundations of analysis in the 19th century. We analyze set theoretic and constructive approaches, and discuss fundamental metamathematical results and their philosophical implications. A "reductive structuralist" position will finally provide a perspective for understanding the abstract character of mathematics as well as its usefulness in applications.

80-314 Logic and Artificial Intelligence

Spring: 9 units

An introduction to several formalisms used in knowledge representation and database theory. The emphasis is placed on non-monotonic logic, conditional logic and belief revision methods. We will also study recent issues in the logics of knowledge and belief and consider applications in distributed AI. Several methodological problems in AI are discussed.

80-315 Modal Logic

Fall: 9 units

An introduction to first-order modal logic. The course considers several modalities aside from the so-called alethic ones (necessity, possibility). Epistemic, temporal or deontic modalities are studied, as well as computationally motivated modals (like 'after the computation terminates'). Several conceptual problems in formal ontology that motivated the field are reviewed, as well as more recent applications in computer science and linguistics. Kripke models are used throughout the course, but we also study recent Kripkean-style systematizations of the modals without using possible worlds. Special attention is devoted to Scott-Montague models of the so-called 'classical' modalities.

80-316 Causation Probability & AI

Fall: 9 units

In this course we will examine foundational questions about the concepts of causality and probability, how artificial intelligence techniques can be used to solve some of the computational problems presented by the use of probabilities and representations of causal relations, and how probabilities and representations of causal relations have been incorporated into recently developed expert systems. The foundational questions we will examine are: What do causal and probabilistic statements mean? How can probabilities and causal relations be inferred? Are there any axioms relating causal relations to probability distributions? What are the advantages and disadvantages of using probabilities as compared to alternative representations of uncertainty? We will then discuss recent developments in Artificial Intelligence (e.g. Bayesian networks) which have solved some of the long-standing computational problems associated with the use of probabilities and statements about causal relations. Finally, we will study in detail some expert systems, such as QMR and Pathfinder, which have incorporated these new techniques in order to perform medical diagnosis.
Prerequisites: 36226 or 36202 or 36217

80-321 Causation, Law, and Social Policy

Fall: 9 units

Policy makers face causal questions. For example, does violence on TV cause violence in life, and if so, what policies can we institute that will actually curb it? Does the death penalty actually deter criminals? Do tough drug laws reduce drug use? This course investigates how scientists establish causal claims, and how policy makers and the courts rely on or systematically ignore such science. We examine what causal claims mean and how they connect to statistical data, and we discuss the limits of standard techniques for establishing causal claims. We will consider all of these issues first theoretically, and then in the context of several case studies chosen mostly by the students. Knowledge of social science and/or statistics is not required, but is desirable.
Prerequisites: 36201 or 36207 or 36217 or 36220 or 36225 or 36247

80-322 Philosophy of Physics

Spring: 9 units

Philosophical problems in the development of modern physics. Topics include the philosophical significance of Einstein's theory of relativity, interpretations of quantum mechanics, and the relationship between these two theories. Other topics may include the philosophy of space and time, the epistemology of geometry, the significance of modern cosmology, and chaos theory.

80-323 Philosophy of Biology

Spring: 9 units

This course will focus on a range of foundational problems in evolutionary biology, including the possibility of meaningful explanations and laws, evolutionary explanations of human behavior from sociobiology and evolutionary psychology, and controversies over the meanings and roles of a variety of foundational concepts (including fitness, adaptation, optimality, and probability). Philosophers have historically played a central role in these debates, and so we will also examine the ways in which the theory and practice of evolutionary biology have changed in light of philosophical arguments and observations. This course will be accessible both to philosophers interested in the epistemological and metaphysical status of evolutionary biology, and to biologists interested in better understanding the foundations of their field. Although there are no formal prerequisites for this course, students will be expected to have taken courses in either philosophy or biology.

80-336 Philosophy of Law

Spring: 9 units

Have you ever wondered what would happen to you if you were clutched by the law on criminal charges, whether justly or unjustly? Or, what defenses would be available to you, according to the law, whatever the charges? Or, what sort of rationales define and delimit criminal offenses and available defenses to specific criminal charges? This course investigates principles, rules, procedures, sensibilities and practical realities of the criminal law in action. Our focus will be the law governing homicide, which, while aiming to protect our most basic human interest in life itself, also allows for the taking of human life. This apparent conundrum provides a compelling invitation to philosophic inquiry. While the law is steeped in apparent intractabilities of conflicted human values, it must also be very practical and decisive. The intersection of Philosophy and Law invites reflection on the relationship between facts and values, the complementarity of scientific and humanistic perspectives, and the interdependence of theory and practice. For depth of perspective, we will (1) analyze in considerable detail controversial real-life scenarios and cases to (2) test the principles underlying the criminal law and legal defenses to the most serious of charges, criminal homicide (e.g., insanity, diminished capacity, duress, provocation, necessity, self-defense, "battered woman" and other "syndromes"), (3) analyze philosophic and legal concepts of justifiability, excusability, culpability, responsibility and criminal liability, and (4) examine similarities in legal and philosophic reasoning. To vivify these issues and illustrate the criminal law, its precepts and procedures in action, we will (5) make extensive use of videos and role-play to 'visit' courtrooms, cases, and scenarios. Overall, (6) the course aims to challenge and sharpen your analytical reasoning skills.

80-341 Computers, Society and Ethics

Spring: 9 units

This course explores many of the social and ethical issues that have emerged in the wake of the significant advances that we have witnessed in computer science and information technology (IT). Computers and communications technologies have had an increasing impact on the whole of society and have raised new and difficult ethical questions. In turn, these ethical issues have spurred the need for a consideration of new policies and regulations. In this new world of IT, some are concerned about the protection of their privacy while others find problems of censorship and, more generally, restrictions on information access to be their main focus as a problematic social issue. This course will address these and other issues such as: questions of free speech, surveillance in the workplace, intellectual property and copyright, information acquisition and ethics and the Internet.

80-344 Management, Environment, and Ethics

Fall: 9 units

This course will survey numerous philosophical and ethical aspects of the environmental movement. It will focus upon such topics as the nature of environmental responsibility, anthropocentric versus biocentric considerations of the environment, animal rights, obligations to future generations and the "land ethics" of Aldo Leopold. It will explore the arguments found in the debates over radical environmental activism, deep ecology, social ecology and eco-feminism. Environmental justice, issues of environmental rights, the possibilities of sustainable environmental practices and the causes of our ecological condition will be discussed in this course as well.

80-380 Philosophy of Language

Spring: 9 units

Philosophy of language involves the attempt to understand the nature of language and its relationship with speakers, their thoughts, and the world. As part of this attempt, philosophers have

asked questions such as: What is language? How does language convey meaning? Is it language itself which determines meaning, or the intentions of speakers? What different kinds of meaning are there? Philosophers and linguists have also asked questions about the meanings and functions of particular linguistic forms, such as definite noun phrases, conditional sentences and words like "I" and "now." In this course, we will read papers by many of the major figures of contemporary philosophy of language: Frege, Russell, Tarski, Davidson, Quine, Kaplan, Grice and others. The course will be run "seminar-style": students will be expected to read papers for each class in preparation for class discussion, and will also be required to take turns presenting the papers in class. The course also has significant writing requirements. By the end of the course, students will be familiar with the central questions of this area of philosophy, with the type of argumentation used to address them, and with some of the solutions that have been proposed. Students enrolling in the course should have taken at least one other philosophy class in which they read papers from the philosophy literature.

80-381 Meaning in Language

Fall: 9 units

This course provides a survey of the different ways in which meaning is conveyed in spoken languages, and of the different types of meaning which are conveyed. Topics to be covered will include: word meaning (lexical semantics); structure and meaning (compositional semantics); information structure (foregrounding and backgrounding); verb argument structure and thematic roles; intonational meaning and focus; presupposition; context dependency; discourse markers and utterance modifiers; and the role of inference in interpretation. The topics to be addressed bring together a variety of fields: linguistics; philosophy of language; communication studies and rhetoric; and language technologies. The course may be taken as either a 9-unit (80-306) or 12-unit (80-606/11-725) course. The 12-unit course will include an additional component, which will relate the content of the course to issues in computational linguistics, with an emphasis on methods of implementation. (The computational component will be taught by faculty from the Language Technologies Institute.) If there is adequate interest, an alternative additional component focusing on linguistic and philosophical literature may be available. Prerequisites: 11521 or 11721 or 76385 or 76386 or 76387 or 76389 or 76451 or 80180 or 80280 or 80380 or 82280 or 82383 or 85421

80-405 Game Theory

Spring: 9 units

Game theory is the branch of decision theory in which decision problems interact. This course will cover those parts of game theory of special interest to social scientists and philosophers. We will discuss specific elements of the formal theory, including: the distinction between cooperative and non-cooperative games, games in the strategic and the extensive form, solution concepts, epistemic conditions needed to predict outcomes of games, equilibrium refinements, dynamical models of equilibrium selection, and folk theorems of indefinitely repeated games. We will discuss results in experimental economics that test some of the assumptions of classical game theory. Throughout the course we will examine applications of the formal concepts of game theory to problems in moral and political philosophy and the social sciences. Prerequisites: background either in decision theory, rational choice, probability, or statistics.

80-411 Proof Theory

Fall: 9 units

This course is an introduction to Hilbert-style proof theory, where the goal is to represent mathematical arguments using formal deductive systems, and study those systems in syntactic, constructive, computational, or otherwise explicit terms. In the first part of the course, we will study various types of deductive systems (axiomatic systems, natural deduction, and sequent calculi) for classical, intuitionistic, and minimal logic. We will prove Gentzen's cut-elimination theorem, and use it to prove various theorems about first-order logic, including Herbrand's theorem, the interpolation theorem, the conservativity of Skolem axioms, and the existence and disjunction properties for intuitionistic logic. In the second part of the course, we will use these tools to study formal systems of arithmetic, including primitive recursive arithmetic, Peano arithmetic, and subsystems of second-order arithmetic. In particular, we will try to understand how mathematics can be formalized in these theories, and what types of information can be extracted using metamathematical techniques. Prerequisites: 21300 or 80310 or 80311

80-413 Category Theory

Spring: 9 units

Category theory, a branch of abstract algebra, has found many applications in mathematics, logic, and computer science. Like such fields as elementary logic and set theory, category theory provides a basic conceptual apparatus and a collection of formal methods useful for addressing certain kinds of commonly occurring formal and informal problems, particularly those involving structural and functional considerations. This course is intended to acquaint students with these methods, and also to encourage them to reflect on the interrelations between category theory and the other basic formal disciplines. Prerequisites: one course in logic or algebra.

80-430 Ethics and Medical Research

Spring: 9 units

Ethics & Medical Research: This course covers foundational issues in the ethical evaluation and regulation of research involving human subjects. It begins with a historical overview of the origins of research ethics after World War II as a response to high profile cases of abuse or scandal. This unit covers "classic cases" including the Tuskegee syphilis study, the Willowbrook hepatitis study, the Jewish Chronic Disease Hospital Case, and others. It also covers seminal documents such as the Nuremberg Code, the Belmont Report, and the current federal regulations known as the Common Rule. Against this historical backdrop, the course then examines foundational philosophical issues in human-subjects research including ethical issues in clinical trial design, the concept of equipoise and the use of placebo controls, the requirements of justice in the research context, and the values of privacy and informed consent.

80-511 Thesis Seminar

Spring: 9 units

This course provides a forum for the presentation and detailed discussion of research done by students, be they undergraduates working on their Senior Thesis or graduate students engaged with their M.S. thesis.

80-513 Seminar of Philosophy of Mathematics

Spring: 12 units

In recent years, fast propositional satisfiability solvers have been developed that can often handle formulas in CNF with hundreds of thousands of variables and millions of clauses. These have made it possible to apply classical decision procedures to domains where, previously, they were applicable only in theory. As a result, we can now reason effectively in the presence of increasingly complex systems of arithmetic and algebraic constraints. This course will survey the fundamental methods behind these core decision procedures. Topics will include Groebner bases, decision procedures for real and integer linear arithmetic, and decision procedures for real closed fields. We will also cover Nelson-Oppen methods, which provide ways of combining decision procedures for languages with restricted overlap. This is a six-unit seminar, but students can earn an additional six units by completing a suitable final project. Prerequisites: logic, math, or computer science background.

80-514 Categorical Logic

Fall: 9 units

This course focuses on applications of category theory in logic and computer science. A leading idea is functorial semantics, according to which a model of a logical theory is a set-valued functor on a category determined by the theory. This gives rise to a syntax-invariant notion of a theory and introduces many algebraic methods into logic, leading naturally to the universal and other general models that distinguish functorial from classical semantics. Such categorical models occur, for example, in denotational semantics. e.g. treating the lambda-calculus via the theory of Cartesian closed categories. Similarly, higher-order logic is treated categorically by the theory of topoi. Note: this course will begin with a 3 week refresher of basic category theory - CS students can start after immigration by reviewing on their own. Prerequisites: 80413

80-516 Seminar on Causation

Fall: 9,12 units

This course explores the foundations of causation. It examines how causal claims connect to both probability and to counterfactuals. Under a variety of background assumptions, and a variety of senses of "reliable", we will examine which causal inferences can be made reliably. We will also examine recent developments in statistics and artificial intelligence relating to causal inference. Prerequisites: 80316

80-520 Seminar on Philosophy Science

Fall: 9 units

A graduate level, critical review of standard issues in the philosophy of science. Topics will include determinism, predictability, confirmation, probability, causation, lawlikeness, explanation, the aims of science, the content of scientific claims, the rationality of belief in scientific claims.

Prerequisites: 80413 or 80713

80-521 Seminar on Methodology

Fall: 9 units

Ockham's razor is the vague but crucial principle of scientific method, named after the 14th century logician and theologian William of Ockham, that one should prefer simpler theories. This raises two obvious questions: what simplicity is and why one should expect the simpler theory to be true. The questions were already raised by Leibniz and Kant and have been discussed by Goodman, Quine, Lewis, Rosenkrantz, Glymour, Kitcher, Friedman and other philosophers. But the significance of the question extends far beyond philosophy, for statistics and machine learning have their own sophisticated accounts of Ockham's razor, including simplicity-biased prior probabilities, sample coverage, structural risk minimization, and Kolmogorov complexity. Each of these approaches will be examined critically and will be found either to evade or to dismiss the central question of how Ockham's razor helps one find the true theory.

Then I will introduce a new foundational account of the nature and scientific role of simplicity, according to which Ockham's razor cannot point straight at the true theory but nonetheless keeps science on the uniquely straightest path thereto. The theory, which is based loosely upon H. Putnam's computational concept of "trial and error predicates" and upon the related, learning theoretic literature on "mind-changes", will be applied to causal discovery, conservation laws, curve fitting and the inference of regular sets. The course will interest anyone who cares about the foundations of scientific method and learning, including students in philosophy, psychology, statistics, machine learning, social and decision sciences, physics, biology or any area in which questions of modeling, causation, or theory choice arise. Students should have some comfort level with basic mathematical logic, probability theory, computability theory, and analysis, all of which are crucial to the topic.

80-522 Seminar on the Foundation of Statistics

Fall: 9 units

The seminar focuses on some single important foundational work, or body of work, and investigates it and related research from a contemporary point of view. For example, when Savage's Foundations of Statistics is the course's focus, the class goals include understanding how Bayesian decision theory differs from its rivals, and understanding where Savage's position is located within the current Bayesian program. Other seminal thinkers whose writings have served as the course's focus in different terms include, R.A. Fisher, Harold Jeffreys, J. Neyman, and A. Wald. Prerequisites: This is primarily a graduate level class. Instructor permission is required for undergraduates.

80-575 Seminar on Metaphysics

Intermittent: 9,12 units

We will begin, appropriately, with readings from Plato and from Aristotle's Metaphysics, which motivate the fundamental questions of metaphysics. With this classical background, we will turn to a range of exemplary contemporary articles concerning such traditional metaphysical questions as the nature of existence, necessity, and causation, the persistence of objects through time, and personal identity. This is an advanced undergraduate class.

80-580 Seminar on the Philosophy of Language

Intermittent: 9 units

Seminar on the Philosophy of Language: The Construction of Meaning. The prevailing standard model of linguistic interpretation traces back to the work of Paul Grice. On Grice's model, the interpretation of a linguistic utterance is a two stage process. First, an interpreter calculates the meaning of the sentence uttered on the basis of the conventional meanings of the words and syntactic constructions used. The output of this compositional process is assumed to be a proposition. Then, the interpreter proceeds to make inferences, based on this proposition and other contextual information, as to what the speaker meant. Crucially, this process (a) treats the truth conditional content of sentences as compositionally determinable on the basis of purely linguistic information and (b) clearly separates the contribution of semantic processes and pragmatic (inferential) ones. This standard picture has been critiqued from a variety of perspectives, and there is an ongoing debate surrounding the theory of the construction of meaning. Some philosophers and linguists have argued that inferential processes indeed do contribute to the determination

of truth conditional content, or "what is said." Others defend some version of the standard view, and have provided a variety of responses to critiques. Both kinds of view come in different degrees, ranging from extreme contextualists to those who deny that naive intuitions about utterance interpretation provide insight into the actual meanings of sentences. In this seminar, we will read the literature in which this debate has been and is being carried out. Readings will primarily be drawn from the philosophical and linguistic literature, with some forays into psycholinguistics and computational linguistics.

80-595 Senior Thesis

Fall and Spring: 3-18 units

Modern Languages**82-101 Elementary French I**

Fall and Spring: 12 units

This course is for students who have never studied French. The emphasis is on all four skills (listening, speaking, reading, writing) and on cultural information as it is presented in the text and through homework assignments. Regular participation in class is mandatory (four in-class hours per week). In addition, this course requires that students spend time in the Modern Language Resource Center (MLRC) using different multimedia tools (audio CD, video, CD ROM, ML server, Internet) to complete assignments. Information on how to use these tools will be provided. The elementary level is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Prerequisite: None. If a student has studied French before, then s/he must take the placement exam. Instructions for taking the placement exam are in Baker Hall 160.

82-102 Elementary French II

Fall and Spring: 12 units

This course is designed for students who have taken first-semester French at Carnegie Mellon or its equivalent. The emphasis is on all four skills (listening, speaking, reading, and writing) and on cultural information as it is presented in class and through homework assignments. Regular participation in class is mandatory (four in-class hours per week). In addition, students will be required to spend some time in the Modern Language Resource Center (MLRC) using different multimedia tools to complete assignments. Information on how to use these tools will be provided. The elementary level is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. If a student has studied French before, then s/he must take the placement exam. Instructions for taking the placement exam are in Baker Hall 160. Prerequisite: 82-101 or 82-103 or placement test for previous instruction in French. Prerequisites: 82101 or 82103

82-103 Elementary French I Online

Fall: 12 units

This course is designed for students who need a more flexible approach to language learning than that offered in a standard classroom course. All materials are Web-based, with extensive use of Internet technologies for research, writing and communication. There is a required weekly class meeting for training and for group activities, plus individual weekly meetings with a tutor or the Instructor for conversation and practice. See www.languageonline.org for a more detailed description of requirements and class structure before enrolling. Elementary French Online at Carnegie Mellon is a LearnLab course for the Pittsburgh Science of Learning Center. This means that researchers are attempting to improve language instruction by studying experimental approaches. Students in this class should be prepared to participate in such studies in the course of their class work. Prerequisites: No previous study required. If a student has studied French before, then s/he must take the placement exam. Instructions for the placement exam are in BH 160. NOTE: There is a *required* \$50 materials fee for taking this course. This fee has to be paid by the end of the add/drop date to avoid removal from the class.

82-104 Elementary French II Online

Spring: 12 units

A continuation of 82-103, Elementary French I Online. There is a required weekly class meeting for training and for group activities, plus individual weekly meetings with a tutor or the Instructor for conversation and practice. See www.languageonline.org for a more detailed description of requirements and class structure before enrolling. Elementary French Online at Carnegie Mellon is a LearnLab course for the Pittsburgh Science of Learning Center. This means that researchers are attempting to improve language

instruction by studying experimental approaches. Students in this class should be prepared to participate in such studies in the course of their class work. Prerequisites: French 82-101, 82-103 or permission of the Instructor. Students new to French study at Carnegie Mellon must take the placement exam. Instructions for the placement exam are in BH 160. NOTE: There is a *required* \$50 materials fee for taking this course. This fee has to be paid by the end of add/drop date to avoid removal from the class. Prerequisites: 82101 or 82103

82-106 Intensive French Language and Culture: Elementary Level
All Semesters: 3-18 units
Transfer credit for study abroad in France, a French-speaking country, or other approved program at the Elementary level. Credit determined after consultation with the transfer credit Advisor for French.

82-110 Self-Study in Less Commonly Taught Languages
Intermittent: 3-18 units
Please visit the Modern Language Office in Baker Hall 160 for the semester specific description of this course. From time to time, the Department may offer a two-semester self-instructional sequence of study in one of the so-called less commonly taught languages (e.g., Indonesian, Polish, Swahili). The course will provide individualized language instruction for students working at their own pace in consultation with a tutor using materials identified by the National Association of Self Instructional Language Programs. Courses emphasize the development of oral-aural skills and introduce basic reading and writing. Students must be prepared to devote at least 15 hours per week to individual study in addition to the time spent each week in consultation with their tutor. Enrollment in the course is limited. Prerequisite: Permission of the Department Head.

82-121 Elementary German I
Fall and Spring: 12 units
An introduction to German for students with no previous background in the language. Listening, speaking, reading, and writing skills are developed in a context that introduces information on culture and life in German-speaking countries of today. Includes work with audio-visual and internet materials. The elementary level is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Four hours of in-class instruction per week. Prerequisite: None. If a student has studied German before, then s/he must take the placement exam. Instructions for taking the placement exam are in Baker Hall 160 and online at <http://webcape.byuhtrsc.org/?acct=cmu&lang=gr>.

82-122 Elementary German II
Fall and Spring: 12 units
This course, the sequel to 82-121, is intended for students with one semester of college German (or equivalent). Listening, speaking, reading, and writing skills are developed in a context that introduces information on culture and life in German-speaking countries of today. Includes work with audio-visual and internet materials. The elementary level is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Four hours of in-class instruction per week. Prerequisite: 82-121 or 82-123 or approved equivalent. Prerequisites: 82121 or 82123

82-123 Directed Language Study: Elementary German I or II
Fall and Spring: 12 units
This course is a directed, Instructor-supervised version of the courses 82-121 or 82-122. It is recommended for (1) students who are well motivated and have the time, self-discipline, and desire to work independently, and (2) students whose schedule precludes enrollment in the regular elementary course and (3) Students who have had previous German study but are not prepared to take 82-122. This course develops the fundamental language skills as outlined in the description of 82-121 or 82-122. Students complete the same work as in 82-121 or 82-122 as well as supplementary video materials. Written work is turned in for correction. Tests covering each unit of material will be taken according to a schedule determined by the Instructor. The Instructor will be available during office hours or by appointment for individual consultations and for testing. Students are permitted to take only one semester of 82-123. YOU MUST ATTEND THE FIRST MEETING. IF YOU CANNOT ATTEND, CONTACT THE INSTRUCTOR BEFORE THE MEETING.

82-126 Intensive German Language and Culture: Elementary Level Intermittent: 6-24 units
Transfer credit for study abroad in Germany, a German-speaking country, or other approved program at the Elementary level. Credit determined after consultation with the transfer credit advisor for German.

82-131 Elementary Chinese I
Fall: 12 units
This course is for beginners in Mandarin Chinese. Its goal is to train students in the basic skills of listening, speaking, reading and writing for daily communication in Chinese. Students will learn the phonetic transcriptions of Chinese (Pinyin) for speaking and listening as well as Chinese characters for reading and writing. Basic vocabulary and sentence patterns used in everyday life are taught so that students will be able to carry on simple conversations on everyday life topics. Students will be introduced to cultural issues through class, extracurricular activities and multimedia programs. The elementary level is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Prerequisite: None.

82-132 Elementary Chinese II
Spring: 12 units
This course is the continuation of the elementary Chinese course sequence for beginning students of Mandarin Chinese. Its goal is to continue to train students in the basic skills of listening, speaking, reading and writing for everyday communication. Based on the vocabulary and sentence structures taught in the first semester, students will learn more useful expressions and sentence structures necessary for use in everyday life. A large part of the class time will be devoted to conversations related to topics on daily life. While emphasis is laid on the communicative skills of listening and speaking, students will continue to learn to read and write short paragraphs and essays in Chinese characters. To facilitate the study of the language, different aspects of Chinese culture and society will be introduced through poetry reading, group activities, multi-media programs, and research project throughout the course. The elementary level is designed to help students learn to reflect and draw upon strategies used by good language learners in their second language study. Prerequisite: 82-131 or approved equivalent. Prerequisites: 82131

82-133 Elementary Chinese Online I
Fall and Summer: 12 units
This course is designed for students who need a more flexible approach to language learning than that offered in a standard classroom course. It is a Chinese language course designed to help beginners develop communicative competence in the four basic skills of listening, speaking, reading and writing the Chinese language. Basic vocabulary and sentence structures for use in essential daily-life situations, as well as cultural information, are taught through the materials and assignments. Materials are web-based, with extensive use of Internet technologies for research, writing and communication. There is a required weekly class meeting for training and for group activities, and weekly individual meetings with a tutor or the instructor for conversation and practice. Elementary Chinese I Online at Carnegie Mellon is a LearnLab course for the Pittsburgh Science of Learning Center. This means that researchers are attempting to improve language instruction by studying experimental approaches. Students in this class should be prepared to participate in such studies in the course of their classwork. Prerequisites: No previous study is required. If a student has studied Chinese before, then s/he must take a placement exam. Instructions for the placement exam are available in BH 160.

82-134 Elementary Chinese Online II
Spring and Summer: 12 units
This course is the continuation of 82-133, Elementary Chinese I Online. Students will continue learning more useful and complex expressions and sentence structures necessary for use in everyday life. Students will continue building their skills in listening, speaking, reading, and writing for everyday communication, and their understanding of Chinese culture and society. There is a required weekly class meeting for training and for group activities, and weekly individual meetings with a tutor or the instructor for conversation and practice. Elementary Chinese II Online at Carnegie Mellon is a LearnLab course for the Pittsburgh Science of Learning Center. This means that researchers are attempting to improve language instruction by studying experimental approaches. Students in this class should be prepared to participate in such studies in the course of their classwork. Prerequisites: Chinese 82-131, 82-133 or permission of the Instructor.

82-135 Intensive Elementary Chinese

Intermittent: 12 units

This course is designed for students who have some basic knowledge of spoken Chinese, but know little of how to read and write Chinese. While students will be trained in all the four language skills of listening, speaking, reading and writing simultaneously, the focus will be on the study and practice of Chinese characters. Based on their speaking ability, students will learn how to communicate in writing in everyday situations. In addition, the acquisition of standard pronunciation and Chinese cultural awareness will be also stressed. After the study of this course students will be well equipped to continue their study of Chinese at the intermediate level. Prerequisite: None

82-141 Elementary Spanish I

Fall and Spring: 12 units

A two-semester course sequence (82-141, 82-142) for beginning students emphasizing the development of communicative language proficiency: oral practice, aural comprehension, reading, writing, structural analysis, and language learning resource center work. Also a study of cultural aspects of Spanish-speaking countries. Prerequisite: None. If a student has studied Spanish before, then s/he must take the placement exam. Instructions for taking the placement exam are in Baker Hall 160.

82-142 Elementary Spanish II

Fall and Spring: 12 units

The second part of a two-semester course sequence (82-141, 82-142). Prerequisite: 82-141, placement score, or permission of the Instructor. If a student has studied Spanish before, then s/he must take the placement exam. Instructions for taking the placement exam are in Baker Hall 160. Prerequisites: 82141 or 82143

82-143 Elementary Spanish I Online

Fall: 12 units

This course is designed for students who need a more flexible approach to language learning than that offered in a standard classroom course. All materials are Web-based, with extensive use of Internet technologies for research, writing and communication (chat and b-boards). There is a required weekly class meeting for training and for group activities, plus individual weekly meetings with a tutor or the Instructor for conversation and practice. See www.languageonline.org for a more detailed description of requirements and class structure before enrolling. Prerequisite: No previous study required. If a student has studied Spanish before, then s/he must take the placement exam. Instructions for the placement exam are in BH 160. NOTE: There is a *required* \$50 materials fee for taking this course. This fee has to be paid by the end of add/drop to avoid removal from the class.

82-144 Elementary Spanish II Online

Spring: 12 units

A continuation of 82-143, Elementary Spanish I Online. This course is designed for students who need a more flexible approach to language learning than that offered in a standard classroom course. All materials are Web-based, with extensive use of Internet technologies for research, writing and communication (chat and b-boards). There is a required weekly class meeting for training and for group activities, plus individual weekly meetings with a tutor or the Instructor for conversation and practice. See www.languageonline.org for a more detailed description of requirements and class structure before enrolling. See www.languageonline.org for a more detailed description of requirements and class structure before enrolling. Prerequisite: 82-141, 82-143 or permission of the Instructor. Students new to Spanish study at Carnegie Mellon must take the placement exam. Instructions for the placement exam are in BH 160. NOTE: There is a *required* \$50 materials fee for taking this course. This fee has to be paid by the end of add/drop to avoid removal from the class. Prerequisites: 82141 or 82143

82-146 Intensive Spanish Language and Culture: Elementary Level All Semesters: 3-18 units

Transfer credit for study abroad in a Spanish-speaking country or other approved program at the Elementary level. Credit determined after consultation with the transfer credit advisor for Spanish.

82-147 Accelerated Elementary Spanish

Intermittent: 12 units

This course is specially designed for students who are not true beginners of Spanish and therefore not appropriately placed in 82-141 but who may lack adequate preparation to enter the second semester of Spanish. Students will engage in a rapid review of first-semester Elementary Spanish materials and then progress

to complete the entire elementary level of Spanish (the second semester) in one semester. Upon successful completion, students will be prepared to continue at the intermediate level. The course emphasizes the development of communicative proficiency through oral practice, aural comprehension, reading, writing, and study of cultural aspects of Spanish-speaking countries. Prerequisites: Permission of the instructor and an appropriate placement exam score.

82-161 Elementary Italian I

Fall: 12 units

A two-semester course sequence (82-161, 82-162) for beginning students emphasizing the development of communicative language proficiency: oral practice, aural comprehension, reading, writing, structural analysis, and language learning resource center work with audio and video tapes. Also a study of cultural aspects of Italy. The elementary level is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Note: This is a 12 unit course.

82-162 Elementary Italian II

Spring: 12 units

A two-semester course sequence (82-161, 82-162). The elementary level is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Prerequisite: 82-161, 82-163 or approved equivalent. Note: This is a 12 unit course. A 9 unit version of this course that does not fulfill DCR3 credits may be offered during a semester for Music students only. Prerequisites: 82161 or 82163

82-163 Directed Language Study: Elementary Italian I or II

Fall and Spring: 12 units

A self-paced version of 82-161/162, for highly-motivated students, capable of working independently. Weekly practice session, language laboratory work with audio and video tapes, periodic achievement tests, and individual consultation. Students are permitted to take only one semester of 82-163. Prerequisite: None.

82-171 Elementary Japanese I

Fall: 12 units

This course is the first part of a two-semester course sequence (82-171, 82-172) for students with no background in Japanese. It emphasizes the development of communicative language proficiency through oral practice, aural comprehension, reading, writing, and the study of cultural aspects of Japanese society. Furthermore, the elementary-level language course is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Four hours in-class instruction per week, plus mandatory homework. Prerequisites: None.

82-172 Elementary Japanese II

Spring: 12 units

This course is a sequel to Elementary Japanese I (82-171) and continues to further the development of communicative language proficiency through oral practice, aural comprehension, reading, writing, and the study of cultural aspects of Japanese society. Furthermore, the elementary-level language course is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Four hours in-class instruction per week, plus mandatory homework assignments. Prerequisites: 82-171 or approved equivalent. Prerequisites: 82171

82-176 Intensive Japanese Language and Culture: Elementary Level

Intermittent: 6-24 units

Transfer credit for study abroad in Japan or other approved program at the Elementary level. Credit determined after consultation with the transfer credit advisor for Japanese.

82-180 Matisse and Picasso: Friends or Foes

Intermittent: 9 units

Picasso and Matisse: Artistic Friends or Foes? Henri Matisse and Pablo Picasso were arguably the greatest of the 20th century European artists. Opinions are divided as to which was the greatest. They first met in Paris in 1906 and continued their contact - sometimes personal, sometimes via friends, dealers and collectors, sometimes by "spying" on each other's work from that moment until Matisse's death in 1954. Much has been written about their relationship, their influence on each other and whether or not they were really friends or foes. This course will examine closely the work of each of these two masters within the context of 20th century European art. It will look at them individually and comparatively,

studying their paintings, sculpture, work in clay and glass as well as their personal relationship. Readings will include personal testimony from those who knew them well, traditional art history texts, several catalogues from major exhibits that compared their work and several videos from these exhibits. Students will be expected to become familiar with the major contributions each of these artists made to 20th century art as well as to the cultural milieu in which they lived and worked.

82-181 Freshman Seminar: Introduction to Russian Culture and Civilization

Intermittent: 9 units

This course is intended to fulfill the Freshman Seminar requirement of the General Education Program. This course will deal with the significant cultural achievements of the Russian people in different fields of culture. The main focus will be on the analysis of relationships between Russian and Western cultural traditions. The topics chosen for discussions are very important for Russian cultural history and will help in understanding and appreciating some specific ways and achievements in the development of Russian popular culture. Distinctive cultural achievements of Russian high culture will also be highlighted, especially through art and music. In addition to reading assignments, seminar discussions and papers in the history of Russian culture and civilization, students will be taken to the performances of the Pittsburgh Symphony and Pittsburgh Opera. Attendance at all cultural events is required. Prerequisite: Freshman status.

82-182 Freshman Seminar: Language and Culture: Language in its Social Context

Intermittent: 9 units

This course will explore the relationship between language and culture as it manifests itself in language use in a wide variety of speech communities throughout the world. The purpose of the course will be to demonstrate the multifaceted and complex relationship between language and culture and how language use both exemplifies cultural values and simultaneously serves to reinforce them. The course will consider a wide variety of topics, all of which demonstrate implicit cultural differences and attitudes as manifested through language use. Illustrative examples include analysis of the relationship between language and thought (the Sapir-Whorf linguistic relativity hypothesis); standard versus vernacular languages; attitudes toward language acquisition as it differs from one speech community to another; bilingualism and multiculturalism in this country and throughout the world; diglossia; language, literacy and education; non-verbal aspects of language use; gender-based differences in language and culture; sociolinguistic variables in the ethnography of speaking; language loss and language maintenance; politics, language planning and language policy and the impact of languages in contact. Prerequisite: Freshman status.

82-183 Freshman Seminar: Constructions of Memory and Modernity

Intermittent: 9 units

This course will focus on the arts in society during the period of intense modernization that begins in the middle of the nineteenth century (the Second Empire in France), with an emphasis on the late nineteenth century and the early years of the twentieth century (approximately until the time of World War I [1914-1918]). We will read a wide range of literary, historical, and cultural works in an interdisciplinary, comparative perspective. Our focus is on the cultures of Western Europe and the U.S., with an emphasis on French, Anglo-Irish and English, and German works; the readings will be complemented by study of the visual arts, especially Impressionism and photography, theater, and opera. We will view some of the latter works on film and video, when available. Prerequisite: Freshman status.

82-184 Freshman Seminar: The Birth and Death of Tragedy

Intermittent: 9 units

This is a freshman seminar, taught in English, and it addresses one of the most important questions in the development of Western culture: what is tragedy, how did it evolve, and what does it mean today? Starting with Aeschylus' *Oresteia* and Aristotle's *Poetics*, the seminar explores the nature of tragedy in ancient Greece as a theatrical experience, a literary form, and an expression of Greek culture. Friedrich Nietzsche's essay *The Birth of Tragedy* offers an interpretation of the meaning of tragedy in its original context and a link to the nature of tragedy in the modern world. Richard Wagner's music drama *Tristan und Isolde* and his theoretical essays, including "Art and Revolution" and "The Art-Work of the Future," further illustrate and develop the theme, showing how a dominant representative of nineteenth century culture sought to reevaluate and reclaim the tragic form, linking it with an extensive critique

of modern culture. Thomas Mann's *Death in Venice* provides an early twentieth century variation on the theme of tragedy, and Sigmund Freud's *Civilization and its Discontents*, like Nietzsche's essay, provides a framework for placing tragedy in its cultural context. Finally, Arthur Miller's *Death of a Salesman* provides a modern American version of the problem of tragedy. Students in this seminar are asked to write short papers every two to three weeks, and the in-class focus is on intensive discussion and analysis of the texts. Prerequisite: Freshman status.

82-186 Freshman Seminar: Introduction to Russian Culture

Intermittent: 9 units

Please visit the Modern Language Office in Baker Hall 160 for the semester specific description of this course. This course will deal with important cultural achievements of the Russian people in different areas. The main focus will be on the analysis of relationships between Russian and Western cultural traditions. The topics chosen for analysis are significant for Russian cultural history. Class discussions will help students in understanding and appreciating some specific ways and achievements in the development of Russian popular culture. Distinctive aspects of Russian high culture will also be highlighted, especially through art and music. The course will include secondary readings, primary documents, and films. Prerequisite: Freshman status.

82-189 Independent Study in Language and Culture-Elementary Level

Fall and Spring: 6-12 units

An opportunity for students who wish to complement their course work at the Elementary Level in their target language and pursue further study at this level. In conjunction with a faculty member, students will arrange a program of study to explore aspects of the target language and culture. Prerequisite: Permission of the instructor.

82-191 Elementary Russian I

Fall: 12 units

This course begins the Russian language sequence and is offered in the Fall semester only. The course takes a communicative approach to teaching basic skills in listening, speaking, reading and writing. Language is presented in communicative contexts illustrating cultural aspects of daily Russian life. Special emphasis is given to developing oral competency. Attendance is required at four hourly class meetings per week. A fifth hour per week is spent on consultation and conversation practice with a course assistant. One to two hours per day must be devoted to study and homework assignments. The elementary level is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Prerequisites: None.

82-192 Elementary Russian II

Spring: 12 units

The second part of a two-semester course sequence (82-191, 82-192). Prerequisite: 82-191 or approved equivalent. Prerequisites: 82191

82-198 Research Training: Modern Languages

Fall and Spring: 9 units

This one-semester research internship is open to second semester freshmen and sophomores with a 3.0 QPA or by petition. The intention of this internship is to involve students in a faculty research project in its early stages. The Undergraduate Coordinator maintains a listing of participating faculty and the current projects on which they are willing to supervise student interns. The general interests of Modern Languages faculty include three broad categories: second language acquisition, cultural studies, and the development of innovative multi-media applications to language teaching. It is intended that students carry out a piece of individual research which will require about ten hours per week. They will be expected to produce a final report. Weekly meetings with the supervising faculty member will be arranged. Students may take this seminar only once. Prerequisite: Permission of the Instructor.

82-201 Intermediate French I

Fall and Spring: 9 units

An integrated approach to the study of the French language and culture by means of grammar review, literary and cultural readings and analysis, and intensive practice in written and spoken French. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in French. This course is designed to strengthen listening, speaking, reading and writing, within the context of an evolving French culture. Varying with each semester,

the course will use classic French texts as well as songs, excerpts from newspapers, magazines or films. Prerequisite: 82-102/104, placement score, or permission of the instructor. Prerequisites: 82102 or 82104

Prerequisites: 82102 or 82104

82-202 Intermediate French II

Fall and Spring: 9 units

An integrated approach to the study of the French culture and language by means of literary and cultural texts and analysis, coupled with a review of elements of French grammar. Intensive practice in written and spoken French also constitutes the basis for this course as a preparation for the advanced level. Students are invited to explore the French and Francophone worlds as they intersect and sometimes clash, with the goal of fostering better cross-cultural awareness. Texts may include: novels, short stories, newspaper articles, songs, television and film. Prerequisite: 82-201, 82-203, placement score, or permission of the instructor. Prerequisites: 82201 or 82203

82-203 Intermediate French I Online

Fall: 9 units

An integrated approach to the study of the French language and culture by means of grammar review, literary and cultural readings and analysis, and intensive practice in written and spoken French. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in French. This course is a parallel offering designed for students who need a more flexible approach to language learning than that offered in a standard classroom course. All materials are Web-based, with extensive use of Internet technologies for research, writing and communication. There is a required weekly class meeting for training and for group activities, plus individual weekly meetings with a tutor or the instructor for conversation and practice. See www.languageonline.org for a more detailed description of requirements and class structure before enrolling. Prerequisite: 82-102, 82-104, or permission of the Instructor. Students new to French study at Carnegie Mellon must take the placement exam. Instructions for the placement exam are in BH 160. NOTE: There is a *required* \$50 materials fee for taking this course. This fee has to be paid by the end of add/drop to avoid removal from the class.

Prerequisites: 82102 or 82104

82-204 Intermediate French II Online

Spring: 9 units

An integrated approach to the study of the French language and culture by means of grammar review, literary and cultural readings and analysis, and intensive practice in written and spoken French. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in French. A continuation of 82-203, Intermediate French I Online, with an emphasis on francophone cultures outside of France. There is a required weekly class meeting for training and for group activities, plus individual weekly meetings with a tutor or the Instructor for conversation and practice. See www.languageonline.org for a more detailed description of requirements and class structure before enrolling. Prerequisite: 82-202, 203, or permission of the Instructor. Students new to French study at Carnegie Mellon must take the placement exam. Instructions for the placement exam are in BH 160. NOTE: There is a *required* \$50 materials fee for taking this course. This fee has to be paid by the end of add/drop to avoid removal from the class.

Prerequisites: 82201 or 82203

82-206 Intensive French Language and Culture: Intermediate Level

Intermittent: 0-18 units

Transfer credit for study abroad in France, a French-speaking country, or other approved program at the Intermediate level. Credit determined after consultation with the transfer credit Advisor for French.

82-221 Intermediate German I

Fall and Spring: 9 units

The overall goal of Intermediate German I is to further develop your linguistic and cultural knowledge, allowing you to feel more comfortable as a user of German. By the end of the semester, you should be able to: . use and understand German in everyday situations. . communicate effectively in general areas and in individual areas of interest. . understand general cultural perspectives in contemporary Germany. . read and understand authentic materials from German-speaking countries. A balance of activities will help the

development of all four skills and of cultural knowledge. Assessment of progress will occur across skills throughout the semester. This course focuses on intercultural concepts and will help you see what things Germans view differently from other nations and what things might be similar. Topics will include issues such as travel, politics, immigration, and music. Taught in German. Prerequisite: 122 or 123 (part 2) or approved equivalent.

Prerequisites: 82122 or 82123

82-222 Intermediate German II

Fall and Spring: 9 units

In this class, you will expand and develop your speaking, listening, reading, and writing skills, as well as your cultural knowledge of German-speaking countries. Topics include: Life and Love in German-speaking countries. This course focuses on intercultural concepts and will help you see what things Germans view differently from other nations and what things might be similar. Topics will include issues such as views on German history, prospects for Germany's future, art and artists, and the German film industry. By the end of the course, you should be able to make yourself understood by and understand German-speakers with experience dealing with foreigners. Taught in German. Prerequisite 221 or approved equivalent.

Prerequisites: 82221

82-226 Intensive German Language and Culture: Intermediate Level

Intermittent: 6-24 units

Transfer credit for study abroad in Germany, a German-speaking country, or other approved program at the Intermediate level. Credit determined after consultation with the transfer credit advisor for German.

82-231 Intermediate Chinese I

Fall: 12 units

This course is the continuation of Elementary Chinese II (82-132). Students will continue to learn the basic skills of listening, speaking, reading and writing for daily communication. More variety of expressions and complicated sentence structures will be taught so that students can carry on daily conversations on various topics related to modern Chinese Society. While equal emphasis will still be given to both Pinyin and characters, students will be encouraged to use more and more Chinese characters with the help of Pinyin. Activities related to the broad spectrum of the Chinese culture will be organized to facilitate the language learning with knowledge of the cultural background of the language. Prerequisite: 82-132 or permission of the instructor.

Prerequisites: 82132 or 82134 or 82135

82-232 Intermediate Chinese II

Spring: 12 units

This is the second semester of Intermediate Chinese, a continuation of the Elementary Chinese course for beginning Chinese students. It aims at helping students expand their vocabulary and knowledge of grammar of the Chinese language by learning more new words, expressions and sentence patterns needed for everyday communication and by consolidating their knowledge through oral and written practice in and out of class. In this course, students will participate in classroom discussions in Mandarin Chinese on various topics concerning everyday life and study and learn to write short paragraphs on those topics in Chinese characters. Different aspects of Chinese culture will also be introduced throughout the course through audio and video tapes, lectures and discussions. Prerequisite: 82-231 or permission of the instructor.

Prerequisites: 82231

82-235 Intensive Intermediate Chinese

Intermittent: 12 units

This course is the continuation of Intensive Elementary Chinese (82-135). Students will continue to learn the basic skills of listening, speaking, reading and writing for daily communication, while more focus on reading and writing Chinese characters. More variety of expressions and complicated sentence structures will be taught so that students can carry on daily conversations on various topics related to modern Chinese Society. Activities related to the broad spectrum of the Chinese culture will be organized to facilitate the language learning. This course can be a substitute for 82-232 for Chinese Minor. Prerequisite: 82-135 or equivalent. Instructor's approval is required to register for this course.

82-236 Intensive Chinese Language and Culture: Intermediate Level
 Spring: Variable units
 Transfer credit for study abroad in China, a Chinese-speaking country, or other approved program at the Intermediate level. Credit determined after consultation with the transfer credit advisor for Chinese.

82-241 Intermediate Spanish I
 Fall and Spring: 9 units
 An integrated approach to the study of the Spanish language and culture by means of grammar review, literary and cultural readings and analysis, and intensive practice in written and spoken Spanish. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in Spanish. The first part of a two-semester course sequence (82-241, 82-242). Prerequisite: 82-142 or approved equivalent.
 Prerequisites: 82142 or 82144

82-242 Intermediate Spanish II
 Fall and Spring: 9 units
 An integrated approach to the study of the Spanish language and culture by means of grammar review, literary and cultural readings and analysis, and intensive practice in written and spoken Spanish. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in Spanish. The second part of a two-semester course sequence (82-241, 82-242). Prerequisite: 82-241 or approved equivalent.
 Prerequisites: 82241 or 82243

82-243 Intermediate Spanish I Online
 Fall: 9 units
 An integrated approach to the study of the Spanish language and culture by means of grammar review, literary and cultural readings and analysis, and intensive practice in written and spoken Spanish. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in Spanish. This course is a parallel offering designed for students who need a more flexible approach to language learning than that offered in a standard classroom course. All materials are Web-based, with extensive use of Internet technologies for research, writing and communication(chat and b-boards). There is a required weekly class meeting for training and for group activities, plus individual weekly meetings with a tutor or the Instructor for conversation and practice. See www.languageonline.org for a more detailed description of requirements and class structure before enrolling. Students new to Spanish study at Carnegie Mellon must take the placement exam. Instructions for the placement exam are in BH 160. NOTE: There is a *required* \$50 materials fee for taking this course. This fee has to be paid by the end of add/drop to avoid removal from the class. Prerequisite: 82-142, 82-144, 82-147 or permission of the Instructor.
 Prerequisites: 82142 or 82144

82-244 Intermediate Spanish II Online
 Spring: 9 units
 An integrated approach to the study of the Spanish language and culture by means of grammar review, literary and cultural readings and analysis, and intensive practice in written and spoken Spanish. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in Spanish. A continuation of 82-243, Intermediate Spanish I Online. This course is a parallel offering designed for students who need a more flexible approach to language learning than that offered in a standard classroom course. All materials are Web-based, with extensive use of Internet technologies for research, writing and communication(chat and b-boards). There is a required weekly class meeting for training and for group activities, plus individual weekly meetings with a tutor or the Instructor for conversation and practice. See www.languageonline.org for a more detailed description of requirements and class structure before enrolling. Students new to Spanish study at Carnegie Mellon must take the placement exam. Instructions for the placement exam are in BH 160. NOTE: There is a *required* \$50 materials fee for taking this course. This fee has to be paid by the end of add/drop to avoid removal from the class. Prerequisite: 82-241, 243, or permission of the instructor.
 Prerequisites: 82241 and 82243

82-246 Intensive Spanish Language and Culture: Intermediate Level
 Intermittent: 3-18 units
 Transfer credit for study abroad in a Spanish-speaking country or other approved program at the Intermediate level. Credit determined after consultation with the transfer credit advisor for Spanish.

82-261 Intermediate Italian I
 Fall: 9 units
 An integrated approach to the study of the Italian language and culture by means of grammar review, literary and cultural readings and analysis, and intensive practice in written and spoken Italian. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in Italian. A two-semester course sequence (82-261, 82-262) for intermediate-level students. Prerequisite: 82-162 or approved equivalent.
 Prerequisites: 82162 or 82163

82-262 Intermediate Italian II
 Spring: 9 units
 An integrated approach to the study of the Italian language and culture by means of grammar review, literary and cultural readings and analysis, and intensive practice in written and spoken Italian. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in Italian. Prerequisite: 82-261 or approved equivalent.
 Prerequisites: 82261

82-271 Intermediate Japanese I
 Fall: 12 units
 This course is the first part of a two-semester course sequence (82-271, 82-272). It takes an integrated approach to the study of Japanese language and culture, consisting of grammar review, reading, and intensive practice in written and spoken Japanese. Course materials include authentic audiovisual and written texts on top of the assigned textbooks. Also integrated are cultural explorations through direct interactions with native speakers. Four hours of in-class instruction per week, plus mandatory homework assignments. Prerequisites: 82-172 or approved equivalent.
 Prerequisites: 82172

82-272 Intermediate Japanese II
 Spring: 12 units
 This course is a sequel to Intermediate Japanese I (82-171) and takes an integrated approach to the study of Japanese language and culture, consisting of grammar review, reading, and intensive practice in written and spoken Japanese. Course materials include authentic audiovisual and written texts on top of the assigned textbooks. Also integrated are cultural explorations through direct interactions with native speakers. Four hours of in-class instruction per week, plus mandatory homework assignments. Prerequisites: 82-271 or approved equivalent.
 Prerequisites: 82271

82-273 Introduction to Japanese Language and Culture
 Intermittent: 9 units
 This course is an introduction to modern Japanese. Given the close link between the Japanese language and culture, the examination of the distinctive characteristics of the Japanese language and its sociocultural context provides important insights into contemporary Japan. The course is taught in English, with no previous knowledge of Japanese assumed. It is intended both for individuals who want to gain a better understanding of modern Japanese society, as well as for students of the Japanese language. Prerequisites: 82-171
 Prerequisites:

82-276 Intensive Japanese Language and Culture: Intermediate Level
 Intermittent: Variable units
 Transfer credit for study abroad in Japan or other approved program at the Intermediate level. Credit determined after consultation with the transfer credit advisor for Japanese.

82-277 The Japanese Language
 Intermittent: 9 units
 This course examines the basic Japanese grammar covered in Elementary and Intermediate Japanese by comparison with English and aids students in systematizing their knowledge of Japanese. After a brief discussion of the overall differences between the two languages and initial training to analyze them cross-linguistically, it deals with specific areas of grammar that exhibit pervasive

structural and semantic differences and serve as exercises for cross-linguistic analysis. On the basis of the discussion and exercises in class, students are required to gather and analyze relevant Japanese data, thereby facilitating their understanding of the grammar point in question and developing their analytical skills. This course is taught in English. Prerequisites: 82-172 or approved equivalent. Prerequisites: 82171 or 82172 or 82271 or 82272

82-278 Japanese Literature in Translation
Intermittent: 9 units

The primary goal of this course is to provide the student with a broad knowledge of post war Japanese Literature with some knowledge of pre-war writers. Students learn not only a body of literature but about the use of fiction to explore Japanese culture in the post-war era. The course will examine the works of post-war Japanese writers with the main focus on issues such as the emergence of the "modern" Japanese novel and its influences; dilemmas of a post-war generation of writers dealing with its experience related to the war; and last, but not least, the relevance of literature in providing insight into a culture. Students will also read essays in Japanese history and literary theory that will provide the tools for interpreting the literature in its own cultural and historical context. Prerequisites: 82-171
Prerequisites: 82171

82-280 Learning About Language Learning
Fall: 9 units

This course is designed for students majoring or double majoring or minoring in Modern Languages or for students seriously contemplating undertaking the study of a foreign language at a future time. Experienced language learners bring to the tasks of learning a new language all sorts of general knowledge about the ways in which languages work as well as techniques for putting this knowledge to practical use. The objectives of this course are to provide students with a basic introduction to those areas of linguistics and psycholinguistics that will facilitate their language learning. Co-requisite: Study of a foreign language.

82-281 Tutoring for Community Outreach
Intermittent: 6-12 units

Students participate in a community outreach program and work in the Pittsburgh Public Schools with elementary, middle or high school students of Chinese, ESL, French, German, Japanese, or Spanish. The elementary school experience may involve regular visits, mentoring, and tutoring at Greenfield Elementary School, Linden School, Liberty School or Frick International Studies Academy. The high school experience invites advanced students, majors, or minors in Chinese, French, German, Japanese, or Spanish to work with language students at Schenley High School or Taylor Allderice High School. Activities in the high schools may involve tutoring, may be remedial, or may be for enrichment. At Schenley High, Carnegie Mellon students may aid in students' preparation for International Baccalaureate Exams in the Spring. During the early weeks of the semester, students will meet individually with the faculty liaison to arrange their community outreach activities and also as a group to prepare for their experience. Depending on the number of units to be earned, during the course of the semester, students will spend a certain number of hours per week engaged in some of the following activities: attending and participating in the individual and group meetings, tutoring four to six hours per week, reading and preparing for the school visits, keeping a journal of tutoring experiences, writing a paper at the end of the term that reflects experiences. Students earn 6 units by spending 4 hours per week at a school site plus completing related activities. Students earn 9 units by spending 6 hours per week at a school site plus completing related activities. Grade will be Pass/Fail, based on the student's fulfillment of the plan set at the beginning of the semester. Prerequisites: Permission of the faculty liaison plus completion of an information sheet and clearance forms available in the Department of Modern Languages.

82-289 Independent Study in Language and Culture-Intermediate Level

Fall and Spring: 9-18 units

An opportunity for students who wish to complement their course work at the Intermediate Level and pursue further study at this level. In conjunction with a faculty member, students will arrange a program of study to explore aspects of the target language and culture. Prerequisite: Permission of the instructor.

82-291 Intermediate Russian

Fall: 9 units

This course further develops communicative proficiency through intensive practice in written and spoken Russian. Complex grammatical structures and stylistic variations are mastered and extensive vocabulary is acquired. Through reading materials,

fictional and non-fictional, acquaintance is made with the basic components of Russian cultural literacy as well as the distinctive cultural aspects of daily Russian life. Attention is directed toward the dynamic interaction of language and culture in order to foster cross-cultural awareness. Three hours of in-class instruction plus one additional hour of practice with a course assistant are mandatory. One to two hours per day outside of these meetings must be devoted to study and homework assignments. Prerequisite: 82-192 or approved equivalent.
Prerequisites: 82192

82-292 Intermediate Russian II

Spring: 9 units

An integrated approach to the study of the Russian language and culture by means of grammar review, literary and cultural readings and analysis, and intensive practice in written and spoken Russian. This course explores definitions of culture and analyzes the dynamic role of language in culture and culture in language, with an aim to foster cross-cultural awareness and self-realization while developing proficiency in Russian. The second part of a two-semester course sequence (82-291, 82-292). Prerequisite: 82-291 or approved equivalent.
Prerequisites: 82291

82-293 Introduction to Russian Culture

Intermittent: 9 units

Russia is one of the oldest European countries and long ago achieved world recognition for its outstanding contributions to Western traditions in art, architecture, music and ballet. This introductory course, based on primary documents, secondary readings, film and music, will help you to understand the distinctive cultural spirit of this great nation. Prerequisite: 82-291 or approved equivalent.

82-294 Topics in Russian Language and Culture

Intermittent: 9-12 units

Content varies with each offering.

82-296 A Century of Russian Film

Intermittent: 9 units

This course surveys the dominant works, directors and genres that have defined Russian filmmaking from its birth to the present day. Films are screened during required evening class meetings. Films and assigned readings in film history, theory and criticism are discussed during additional required class meetings.

82-299 Alternative Break Project (General)

Fall and Spring: 3, 6 units

SECTION A: "Alternative Break" campus student organization trip to CONGAL Bio-Marine Reserve in Ecuador This course is open ONLY to students participating in the "Alternative Break" student organization's spring 2008 trip to the CONGAL Bio-Marine Reserve in Ecuador. Students will interact and work with personnel from the Reserve and local inhabitants on preservation projects at one of five ecological habitats under the care and supervision of the CONGAL (an Ecuadorean NGO). The class will require some reading, journal writing, critical analysis, and discussion. Students will earn 3 units for their participation. PREREQUISITE: STUDENTS MUST SEEK INSTRUCTOR PERMISSION TO BE ADDED TO THIS COURSE AND WILL ONLY BE ADDED AFTER CONFIRMED ACCEPTANCE INTO THE SPRING 2008 'ALTERNATIVE BREAK' TRIP TO ECUADOR.

SECTION B: Trip to Nicaragua This course is open ONLY to students in the Global Studies House who are traveling to Nicaragua for the GS alternative break program. Students will gain insight into the history of the country, as well as into some of the challenges it currently faces as it moves forward in the 21st century. Students will pay particular attention to issues related to trade, social justice, the environment and health care, as connected to their themes in the Global Studies house. The class will require some reading, journal reflections, critical analysis and discussion. Students will earn 3 units for their participation. PREREQUISITE: STUDENTS MUST CURRENTLY RESIDE IN THE GLOBAL STUDIES HOUSE AND WILL ONLY BE ADDED TO THE COURSE WITH PERMISSION OF THE INSTRUCTOR.

82-301 French for Reading Knowledge

Intermittent: 9 units

This course offers an introduction to the written French language for undergraduate students in the humanities. Students will be introduced to the structure of the French language in order to prepare them for their own research needs that will require consultation of sources in French. The course is not intended to develop writing, listening and speaking skills, nor is it intended to prepare students for further study in the regular undergraduate

French program. It is intended to help them meet specific needs in their research in areas such as history, art and music history, literature, and literary and cultural studies. Prerequisite: Permission of the instructor.

82-303 French Culture
Fall and Spring: 9 units

The purpose of this class is to advance grammatical, communicative and cultural proficiency, through an in-depth study of France and the French. Attempts will be made at defining the French "identity", or what it means to be French, through the study of aspects of French history, French institutions, regions, literature, etc. Examples may be drawn from television and films, songs, and complete literary works, spanning the ages. Great emphasis will be placed on the expression of critical judgment in both oral and written form, documented through readings and personal research. Prerequisite: Completion of the intermediate level or the equivalent. Prerequisites: 82202 or 82204

82-304 The Francophone World
Fall and Spring: 9 units

This course introduces the student of French to several of the francophone regional cultures outside of France, including North and West Africa, Belgium, Switzerland, Quebec and North America, and the Antilles. The culture commonly associated with the French language is the primarily Christian and Cartesian European tradition. Through the experience of this course, you will learn of the multiple synthetic cultural realities which have arisen through the colonial and post-colonial processes of contact between European and non-European cultures, and which are now expressed through the medium of the French language. Materials studied will include novels, short stories, essays, newspaper and scholarly articles, film, documentary video and song. The course also introduces students to the formal requirements of continuing cultural study, thus assignments will include analyses that demonstrate the ability to express critical judgments in both written and oral form, using accepted academic conventions for research documentation and exposition. Prerequisites: 82-303 or permission of the instructor. Prerequisites: 82-303 or permission of the instructor. Prerequisites: 82202 or 82204

82-305 French in its Social Contexts
Fall: 9 units

This course will focus on culture through language variation in spoken and written forms of French. Readings, videos, web use, and in-class conversations will involve phonological and sociolinguistic aspects of the French language and language change, its use regarding different registers and regional languages within France, the question of social identity through language, immigration and generational issues, and an exploration of the distinctive francophone uses of the French language. In addition, students will be prepared to discuss current issues in France and francophone regions/countries by using multimedia tools available in the Modern Language Resource Center (MLRC). Prerequisite: Completion of at least one 300-level French course, placement score, or permission of Instructor. Prerequisites: 82303 or 82304

82-306 Intensive French Language and Culture: Advanced Level
Intermittent: 3-18 units

Transfer credit for study abroad in France, a French-speaking country, or other approved program at the Advanced level. Credit determined after consultation with the transfer credit advisor for French.

82-323 Germany, Austria and Switzerland in the 20th Century
Fall: 9 units

This course advances proficiency in communicative and grammatical skills in the German language and knowledge of German-speaking cultures through the study of important events, trends, and people of the twentieth century in Germany, Austria, and Switzerland. Examples will be drawn from literature, newspapers, television, film and other sources. Students will be expected to complete assignments that demonstrate the ability to express critical judgments in both written and oral form, documented through readings and personal research. Prerequisite: 82-222 or approved equivalent. Prerequisites: 82222

82-324 Contemporary Germany, Austria and Switzerland
Spring: 9 units

This course advances proficiency in communicative and grammatical skills in the German language and knowledge of German-speaking cultures through the study of important events, trends, and people of contemporary Germany, Austria, and Switzerland. Examples will

be drawn from literature, newspapers, television, film and other sources. Students will be expected to complete assignments that demonstrate the ability to express critical judgments in both written and oral form, documented through readings and personal research. Prerequisite: 82-222, 82-323, 82-325; or with permission of the instructor.

Prerequisites: 82222 or 82323 or 82325

82-325 Introduction to German Studies
Fall: 9 units

The Italian literary theorist Franco Moretti has written that "Germany is a sort of Magic Stage, where the symbolic antagonisms of European culture achieve a metaphysical intractability, and clash irreconcilably. It is the centre and catalyst of the integrated historical system we call Europe." This course is a general introduction to German culture, German history, and German society, with a focus on Germany's role as center and catalyst of the European system. The course is conducted entirely in German. Its goal is to provide students with a basic level of cultural literacy about the German-speaking world. In the course, we will study major trends from the earliest days of German civilization through the middle ages but with primary emphasis on the 18th, 19th and 20th centuries and with a special focus on problems of national, political and cultural identity. Students coming out of the course should have a broad understanding of the various tensions and problems that have characterized German culture and society for the last two centuries. In addition to broadening students' cultural knowledge about the German-speaking world, this course will continue to emphasize the improvement of students' ability to speak, read, write, and listen to German. Prerequisite: 82-222, or 82-323, or 82-324; or permission of the instructor. Prerequisites: 82222 or 82323 or 82324

82-326 Intensive German Language and Culture: Advanced Level
Intermittent: 6-24 units

Transfer credit for study abroad in Germany, a German-speaking country, or other approved program at the Advanced level. Credit determined after consultation with the transfer credit advisor for German.

82-331 Advanced Chinese I
Fall: 9 units

This course is designed for students who have reached the intermediate level of proficiency in the use of Chinese language. With emphasis on the communicative functions of the language, it aims at generating students' language process competency in all four skills of listening, speaking, reading and writing. More complex language phenomena needed for communication in a variety of discourse will be introduced through texts as well as multi-media programs closely related to various social issues in China to provide students with the necessary knowledge of the language and its background. Classroom discussions will be an important part of the course followed by the practice of writing of essays on topics related to various social issues in China. With Pinyin as a help, students are required to use both the traditional and simplified forms of Chinese characters in their reading and writing. Prerequisite: 82-232, 82-235 or approved equivalent. Prerequisites: 82232 or 82235

82-332 Advanced Chinese II
Spring: 9 units

A continuation of Advanced Chinese I, this course is designed to train students with the ability to use Chinese language to deal with abstract topics they may encounter in their life. Students will continue to learn more complex language phenomena in order to do exposition, explanation, description and argumentation with the language. These language phenomena will be introduced to students together with their social and cultural background through texts and multi-media programs related to various social issues. Classroom discussions will be the major form of practice. Students will discuss and comment on issues related to family, love, marriage and other human relations as well as the economic situations in the Chinese society by using their language skills in narration, description, comparison, argumentation, etc. Students will also be required to write short articles of 300-500 Chinese characters on various topics discussed in class. Prerequisite: 82-331 or approved equivalent. Prerequisites: 82331

82-333 Introduction to Chinese Language and Culture
Fall: 9,12 units

This course will introduce the students to the Chinese language and culture from a historical as well as contemporary point of view. It is intended to help students develop awareness of and sensitivity to Chinese culture and society and to gain a better understanding of Chinese ways of thinking. Students will be exposed to different

aspects of Chinese culture and their relationship with the language. Class activities will include lectures by the Instructor and guest speakers, seminars, movies, videos and other multimedia materials. Hands-on experience will also be a part of the course. This course is conducted in English with no knowledge of Chinese language required. Those who take this course toward Chinese Minors will be assigned extra work in Chinese to fulfill the requirement for the extra 3 units. Prerequisite: 82-232 or approved equivalent for students seeking credit toward the Chinese minor. No prerequisites for non-minors.

82-334 Structure of Chinese

All Semesters: 9 units

This is an upper-level Chinese course for students who have reached intermediate level of Chinese. It aims at helping students to further develop and refine their Chinese speaking and writing skills. This course will deal with major structural phenomena in Modern Chinese through the study of sample texts. Special emphasis will be given to high frequent errors and individual weaknesses on particular problematic elements and sentence structures that are common among non-native Chinese speakers. After the study of this class, students are expected to have a more comprehensive and systematic understanding of the structure of the language, which will help them lay a solid foundation for their language proficiency. Prerequisite: 82-232, 82-235 or approved equivalent. Prerequisites: 82232 or 82235

82-335 Readings in Chinese

Intermittent: 9 units

This is an upper-level Chinese reading course for students who have reached intermediate level of Chinese. It aims at helping students further develop and refine their Chinese reading and writing skills. Its major goal is to train students the ability to read in Chinese with fluency and proficiency within a format of rich cultural content. Readings will include traditional fables, mini-stories and articles on the lifestyle and social changes in modern China. While class discussion will be the major form of class activities, students are also expected to enhance their vocabulary building and improve their sense of Chinese language through extensive reading and writing assignments. Prerequisite: 82-232 or approved equivalent. Prerequisites: 82232

82-336 Intensive Chinese Language and Culture: Advanced Level

All Semesters: Variable units

Transfer credit for study abroad in China, a Chinese-speaking country, or other approved program at the Advanced level. Credit determined after consultation with the transfer credit advisor for Chinese. Prerequisite: 82-232
Prerequisites: 82232

82-337 Chinese for Oral Communication I

Fall: 9 units

This is an upper-level course focused on the improvement of students' oral communicative competence and self-expression in Chinese. It is designed for students who have reached intermediate level in reading and writing Chinese but have little knowledge of mandarin Chinese pronunciation, as well as those who aim to further improve their speaking in Chinese. Emphasis will be given to helping students develop the accuracy and fluency which characterize the speech of native Mandarin speakers. Students will be introduced to Pinyin, the phonetic system of Mandarin Chinese, and work to refine and perfect their speaking skills through special attention to different styles, colloquialisms, and dialectal variations of contemporary spoken Mandarin. Course materials will include authentic Chinese TV programs, documentaries, films, recorded materials, and contemporary literary and non-literary texts. Students will be required to participate in intensive speaking activities, such as interviewing native speakers of Chinese, oral presentations, discussions, debates, and special projects. At the end of the course, students are expected to carry on oral communication with native Mandarin speakers in a clearly participatory fashion on topics related to various social issues in Modern China. Prerequisite: 82-232, 82-235 or approved equivalent. Prerequisites: 82232

82-338 Chinese for Oral Communication II

Spring: 9 units

This course is designed for students who have reached an intermediate level in reading and writing Chinese, and who would like to promote their oral communicative competence and knowledge of Chinese culture. It is a seminar-type class that relies on active participation from the students. Students will practice various conversational tasks, such as giving presentations, participating in discussions and debates, interviewing, describing, and interpreting. Topics will include current events and cultural

trends in the U.S. and China, analysis of Chinese culture and comparisons with other cultures, contemporary Chinese television shows and movies, and other debatable and interesting issues. Prerequisite: Intermediate level in reading and writing Chinese. Permission of the Instructor.
Prerequisites: 82232

82-341 Advanced Spanish Transfer Credit

All Semesters: Variable units

This course number is given to advanced courses in Grammar, Composition, Conversation, or other appropriate advanced coursework taken as part of a study abroad program or at another institution. Prerequisites: Completion of the intermediate level, prior permission of the Hispanic Studies major or minor advisor and confirmation of credit upon return.
Prerequisites: 82242

82-342 Spain: Language and Culture

Fall and Spring: 9 units

This course is part of the post-intermediate, 300-level program that forms the introduction to the major or minor in Spanish. Students may begin with any one of the three or they may be taken concurrently. Spain focuses on the cultures of Spain, the autonomous regions and the creation of a national identity as a reaction to the multiple ethnicity's that have inhabited the peninsula since ancient times. The course advances proficiency in grammatical accuracy, the ability to communicate one's ideas in Spanish, and cultural proficiency. The focus of in-class activities is on written and non-written sources such as history, literature, film, art, and elements of popular culture; the building of reading and writing skills will be complemented by continued oral practice in the form of small and large group discussions and class presentations. Treatment of reading selections is designed to increase students general familiarity with a variety of genres, devices, and discourse types and to build a foundation for the department's more advanced courses in literature, history and culture. Writing assignments will involve reflective essays, individualized research, and the generation, expression, analysis and re-writing of ideas. Prerequisite: Completion of the intermediate level or the equivalent or permission of the instructor.
Prerequisites: 82242 or 82244

82-343 Latin America: Language and Culture

Fall and Spring: 9 units

This course is part of the post-intermediate, 300-level program that forms the introduction to the major or minor in Spanish. Students may begin with any one of the three or they may be taken concurrently. Latin America focuses on the cultures of Spanish-speaking countries in the Americas (excluding the United States), and the unique hybrid cultures formed from the fusion of indigenous, European and African influences. The course advances proficiency in grammatical accuracy, the ability to communicate one's ideas in Spanish, and cultural proficiency. The focus of in-class activities is on written and non-written sources such as history, literature, film, art, and elements of popular culture; the building of reading and writing skills will be complemented by continued oral practice in the form of small and large group discussions and class presentations. Treatment of reading selections is designed to increase students general familiarity with a variety of genres, devices, and discourse types and to build a foundation for the department's more advanced courses in literature, history and culture. Writing assignments will involve reflective essays, individualized research, and the generation, expression, analysis and re-writing of ideas. Prerequisite: Completion of the intermediate level or the equivalent or permission of the instructor.
Prerequisites: 82242 or 82244

82-344 U.S. Latinos: Language and Culture

Fall and Spring: 9 units

The purpose of this course is to provide review and practice of the four skills ? reading, writing, listening and speaking ? at the advanced level, in Spanish. All work in this course, in the four skill areas, will be stimulated by and be the product of an advanced introduction to and analysis of the cultures and histories of the Hispanic peoples in the United States of America. Many of these people have been and are native born; others are descendants of natives and/or colonizers who resided in North America prior to the arrival of Anglo-Germanic peoples. Many have migrated from Mexico, the Hispanic Caribbean, Central and South America, and Spain during the past two centuries, for economic and/or political reasons. Still others have migrated under special circumstances, as exiles escaping from repressive regimes or from wars in their homelands. Our exploration of U.S. Latino history and culture will compare and contrast the experiences of Hispanics from all three of the above-described categories and analyze the dynamic

tension amongst them, with other minority groups, and with the mainstream society. Prerequisite: Completion of the intermediate level or equivalent or permission of the instructor.
Prerequisites: 82242 or 82244

82-345 Hispanic Literary and Cultural Studies

Intermittent: 9 units

FALL 2008 Hispanic Literary and Cultural Studies: The Last Case of the Hispanic Detective One of the most important cultural phenomena in the Hispanic World since the second half of the 20th century is the development of a specific and idiosyncratic detective genre. This course is a thematic introduction to the cultural production of the transatlantic, Hispanic world (Spain and the two Americas) through the lens of the Hispanic detective genre as found in texts, film, music, and other arts. We will be using detective texts as a site to inquire about the crucial social, political, and economic forces shaping the histories and cultures of the Hispanic world. Topics will include the role of race, religion, sexuality and gender, immigration and exile, and the role of language and discourse in the Hispanic world. Materials will include narratives, films, plays, comics and graphic novels, slides, digital images, and recordings. Classic narratives and films of the genre (e.g., texts by S. Ocampo, J.L. Borges, P.I. Taibo II, R. Piglia, M.V. Montalbán, among others) will be studied alongside some more recent examples and a selection of theoretical readings. Assignments will include reading, research, writing, single and group presentations, quizzes and exams. This course will prepare specialists and non-specialists in Spanish for advanced study at the 400-level and beyond. Prerequisite: Completion of two 300-level Hispanic Studies courses or permission of the instructor.
Prerequisites: 82342 and 82343

82-346 Intensive Spanish Language and Culture: Advanced Level

Intermittent: 18,24 units

Transfer credit for study abroad in a Spanish-speaking country or other approved program at the Advanced level. Credit determined after consultation with the transfer credit advisor for Spanish.

82-358 Literacies Across Language and Culture

Intermittent: 9 units

This course examines differences and similarities in the ways literacy is learned and used in diverse languages and cultures. By clarifying the distinct characteristics of spoken and written communications, we will first analyze what was made possible through the invention of writing, and in so doing, explore the social and cognitive consequences of literacy. We will then scrutinize literacy utilization in a variety of cultural contexts, as well as its collective impacts on the users. Lastly, through systematic comparisons of literacy education, we will identify the social, cognitive, linguistic factors, which shape literacy in particular cultural contexts.

82-361 Introduction to Italian Culture

Fall: 9 units

The course will focus on contemporary aspects of politics, economics, and the social and literary life of Italy. Material will include readings of short stories, magazine and newspaper articles as well as music and movies. Students will participate in a weekly "rassegna stampa" (press review) to keep up to date with current events, giving them an opportunity for discussion and critical analysis through personal research. Students will improve their communication skills as well as enhance comprehension in reading and listening while developing a strong sense of appreciation for contemporary Italian culture. prerequisite: 82-262 or permission of the instructor. The course will be conducted in Italian with occasional English.
Prerequisites: 82262

82-362 Italian Language and Culture

Spring: 9 units

"82-362 Italy as Seen through Film" According to Federico Fellini "A different language is a different vision of life". This course will offer a cultural journey that will enrich the student's perspective on Italy and the Italians. It will be a view of contemporary Italy through the lens of Italian filmmakers. Screenings of movies in the Italian language will be followed by a "cineforum", a roundtable discussion and critique of the major themes introduced by the director. The films, forums, and background research will serve as a vehicle for developing and improving all aspects of communication in Italian from the spoken to the written language. Film selections will range from the classics to recent popular hits. The course will be conducted in Italian. Prerequisites: 82262 or permission of the instructor

82-371 Advanced Japanese I

Fall: 9 units

A two-semester course sequence (82-371, 82-372). This course emphasizes the acquisition of an advanced level of communicative language proficiency by immersing students in authentic cultural explorations. Curriculum includes authentic reading texts, audiovisual materials, interviews with native speakers, and viewing and summarizing Japanese films that depict current Japanese society and cultural trend. The course also provides an individualized learning environment throughout the term in improving students' language skills and cultural proficiency. Students may pick a topic of personal interest for their term project thesis. Prerequisite: 82-272 or approved equivalent.
Prerequisites: 82272

82-372 Advanced Japanese II

Spring: 9 units

A sequel to Advanced Japanese I (82-371). This course continues to further improve the acquisition of the advanced level communicative language proficiency by immersing students in authentic cultural explorations. Curriculum includes authentic reading texts, audiovisual materials, interviews with native speakers, and viewing and summarizing Japanese films that depict current Japanese society and cultural trend. The course also provides an individualized learning environment throughout the term in improving students' language skills and cultural proficiency. Students may pick a topic of personal interest for their term project thesis. Prerequisites: 82371 or approved equivalent.
Prerequisites: 82371

82-373 Structure of the Japanese Language

Intermittent: 9 units

This course examines the basic Japanese grammar covered in Elementary and Intermediate Japanese by comparison with English and aids students in systematizing their knowledge of Japanese. After a brief discussion of the overall differences between the two languages and initial training to analyze them cross-linguistically, it deals with specific areas of grammar that exhibit pervasive structural and semantic differences and serve as exercises for cross-linguistic analysis. On the basis of the discussion and exercises in class, students are required to gather and analyze relevant Japanese data, thereby facilitating their understanding of the grammar point in question and developing their analytical skills. This course is taught in Japanese. Prerequisites: 82-272 or approved equivalent.
Prerequisites: Corequisites: 82-272

82-374 Technical Japanese

Intermittent: 9 units

This course is the first course in Technical Japanese. It will introduce students to expository styles in Technical Japanese. It will explore technical terms and concepts in electrical engineering, computer science and computer engineering. In addition, it will enable students to acquire knowledge of some kanjis used frequently in Technical Japanese. This course will also provide students with practical information as well as cultural information in the contexts of Japanese science and technology. Furthermore, the students are given an opportunity to work with a Japanese student/researcher for a final project. Prerequisites:82-272, or approved equivalent.
Prerequisites: 82271 or 82272

82-376 Intensive Japanese Language and Culture: Advanced Level

Intermittent: Variable units

Transfer credit for study abroad in Japan or other approved program at the advanced level. Credit determined after consultation with the transfer credit advisor for Japanese.

82-378 Japanese Conversation Analysis

Intermittent: 9 units

Through analysis of various registers of the Japanese Spoken language, this course aims to provide analytical tools for Japanese conversational analysis and to provide opportunities to students to practice high proficiency level of oral communication skills such as formal speech, job interviews, and business communication. Formality, politeness, and gender differences are some of the major topics discussed in this course as well as speakers' perspectives, attitudes and emotions. This course is offered in Japanese.
Prerequisites: 82-272 or approved equivalent.

82-380 Independent Study in Second Language Acquisition

Spring: 9 units

An opportunity for students who wish to pursue independent supervised study in second language acquisition (SLA). In conjunction with a faculty member, students will arrange a program of study to explore aspects of SLA. Prerequisite: Permission of the Instructor.

82-383 Second Language Acquisition: Theories and Research
Fall: 9 units

This course provides an introduction to research and theories in Second Language Acquisition (SLA). Processes that underlie the learning and use of second languages are examined from four perspectives: 1) as linguistic knowledge, 2) as a cognitive skill, 3) as a personality-mediated process, and 4) a socio-culturally mediated process. Factors examined include: age-related differences, the influence of the first language, the role played by innate (universal) principles, the role of memory processes, attitudes, motivation, personality and cognitive styles, and formal versus naturalistic learning contexts. Issues that arise from the course readings are investigated through practical experience in applying theoretical knowledge to small-scale empirical research projects. Students are also provided with opportunities to consider the relevance of these issues to their own language learning experiences. Prerequisite: None however 82-280 "Learning about Language Learning" is strongly recommended.
Prerequisites: 82280

82-384 Language and Culture: Language in its Social Context
Intermittent: 9 units

The focus of this course is an examination of the dynamic role that language plays in a multitude of social contexts throughout the world. The goal of the course is to develop students' sensitivity and awareness to the dual role of language both as a reflection of prevailing social attitudes and as a force that serves to perpetuate many social attitudes and roles. This complex relationship between language, society, culture and personal identity will be demonstrated by examining language use in a wide variety of speech communities throughout the world. The course will consider numerous diverse topics, all of which demonstrate implicit cultural differences and attitudes as manifested through language use. Examples of topics to be considered include standard versus vernacular languages; dialects and variation, language attitudes, bilingualism and multiculturalism in the United States and throughout the world; diglossia; language, literacy and education; non-verbal aspects of language use; gender-based differences in language and culture; socio-linguistic variables in the ethnography of speaking; language loss and language maintenance; politics, language planning and language policy and the impact of languages in contact. The course will be taught on a seminar basis and will involve regular fieldwork activities to bring the themes of the course to life.
Prerequisite: None.

82-385 Language Across the University

Fall and Spring: 3-12 units

Language credit may be attached to any course, independent study, or project unit for which a student receives content-area academic credit. The program is available at the discretion of the responsible content-area faculty, who should be sufficiently skilled in the chosen language to be able to evaluate the technical content of a student's work. The student, content-area faculty and language faculty negotiate a plan for the semester's work, designed to consume approximately three hours per week for three units of academic credit. The course may be repeated on multiple occasions.
Prerequisites: Intermediate level language proficiency or above and permission of a content-area faculty member and the Department of Modern Languages.

82-387 The Film Festival

Intermittent: 9 units

The Film Festival is an annual offering which rotates between the Departments of English, History and Modern Languages, with a different annual theme selected by the Instructor. A core element every year is the study of the Film Festival itself as a global cultural and economic phenomenon. Students in the course will also participate in the planning, promotion and running of a public film festival based on the annual theme and presented to the Carnegie Mellon and Pittsburgh film communities in McConomy Auditorium.
Prerequisite: None.

82-388 Understanding Second Language Fluency

Fall: 9 units

This course will explore the notion of second language (L2) fluency from various perspectives. The major objective of the course will be to help students develop an understanding of what it means to be "fluent" in a second language and to help them improve their OWN fluency. We will examine the notion of "fluency" itself and explore several of the common assumptions, definitions, contradictions and problems associated with the use of this commonly used term, in both first and second languages. Students will undertake a series of fieldwork projects in their second language. These projects will include explorations of native speaker perceptions of L2 fluency and analyses of how these subjective perceptions relate to actual

features of language use. Students will analyze samples of their own L2 speech to see how their second language use coincides with commonly used references to fluency and ways in which they may improve their own language fluency.

82-389 Independent Study in Language and Culture-Advanced Level

Fall and Spring: 3-12 units

An opportunity for students who wish to complement their course work at the Advanced Level (in 300-level courses) and pursue further study at this level. In conjunction with a faculty member, students will arrange a program of study to explore aspects of the target language and culture. Prerequisite: Permission of the Instructor.

82-391 Advanced Russian I

Intermittent: 9 units

This course seeks to enhance listening-comprehension skills while perfecting the linguistic and stylistic practices of advanced students. Intensive study is made of varied literary, journalistic and colloquial texts in audio-visual and print media. Focus is on rapid vocabulary expansion as well as correction of high frequency syntax errors that persist beyond the intermediate level. Practice with online resources, additional to three class hours per week, is mandatory for the evolution of aural/oral fluency. Written compositions and translations, assigned for homework, are required for the development of grammatical accuracy and stylistic appropriateness. All class discussions are conducted in Russian. Prerequisite: 82-292 or approved equivalent
Prerequisites: 82292

82-392 Advanced Russian II

Intermittent: 9 units

The second part of a two-semester course sequence Prerequisite: 82-391 or approved equivalent.
Prerequisites: 82391

82-396 The Faust Legend at Home and Abroad

Intermittent: 9,12 units

This course introduces students to the basic outlines of the Faust story, and examines its nineteenth- and twentieth-century manifestations in a variety of European, Russian and American novels, plays, films and operas. On the assumption that cultures reveal something distinctive about themselves by the particular way in which they adapt the legend, this course aims to discover how and why these Faustian works of art respond and contribute to the social, political and historical context in which they are produced. On what is the persistent appeal of the Faust legend based? To what needs does it speak? How does the history of its own, continual reemergence affect the meanings it communicates? These questions are entertained as seminal works (Christopher Marlowe's "The Tragical Life of Doctor Faustus", Johann Wolfgang von Goethe's "Faust: A Tragedy", Charles Gounod's "Faust") and their progeny are studied. The latter could include: George Sand's "A Woman's Version of the Faust Legend", F. W. Murnau's "Faust", Ivan Turgenev's "Faust", Stravinsky's "The Rake's Progress", Mikhail Bulgakov's "Master and Margarita", Busoni's "Doktor Faust", Tarkovsky's "Solaris", Vaclav Havel's "Temptation", Christa Wolf's "Accident", and Istvan Szabo's "Mephisto". Prerequisites: None for 9 units; an additional 3 units, requiring permission of the instructor, can be earned for work done in Russian.

82-397 Russia's Demons

Intermittent: 9-12 units

Demons and devils, ghosts and goblins, witches and werewolves: Russian literature, art and music and are riddled with them. Where have they come from and why have they stayed? Under what conditions has Russian life conjured them, and what has their power been for creating conditions of their own? This course aims to find out by peering into the netherworld of demonic fantasy by the light of Russian social history from the nineteenth century to the current day. The core of the course is comprised of readings drawn from the literature of Pushkin, Lermontov, Gogol, Dostoevsky, Bely, Lunacharsky and Bulgakov. Additional attention is paid to Vrubel's painting and Prokofiev's music, among others. Prerequisites: None for 9 units; an additional 3 units, requiring permission of the instructor, can be earned for work done in Russian. Prerequisite: none
Prerequisites: 82292

82-399 Special Topics Russian

Fall and Spring: 3-12 units

This course will focus on further development of the linguistic and stylistic practices of advanced students based on cultural analysis of Russian literature. Focus is on rapid vocabulary expansion as well as

correction of high frequency syntax errors that persist beyond the intermediate level. Written compositions and translations, assigned for homework, are required for the development of grammatical accuracy and stylistic appropriateness. All class discussions are conducted in Russian.

Prerequisites: 82391

82-401 French Popular Song

Intermittent: 9 units

This class will look at the phenomenon of popular song in a francophone context. We will adopt multiple points of view, including not only song as music and lyrics, but song as an event in a socio-historical context, as performance, as an industry, as a means of cultural promotion, as a focus for technical innovation in instrumentation, recording, sound reinforcement, and distribution. Where appropriate we will study and listen to individual artists or groups who exemplify trends in these areas. The second half of the course will move our attention to a survey of regional development, beginning with France, then Quebec and finishing with the Cajun music of Louisiana, in what we hope is not a nod in memoriam to an important part of American culture. Prerequisite: Completion of third year courses or permission from the instructor.

Prerequisites: 82303 and 82304

82-404 Francophone Realities: Africa

Spring: 9 units

This course introduces students to the political and sociological histories of former French African colonies. Authors will vary by offering. The literary component of the course involves analyses of francophone authors, examining their roles in the written medium as they attempt to explore colonialism and its effects on Africa.

Prerequisite: 82-303 and 82-304 or approved equivalent.

82-406 Intensive French Language and Culture: Advanced Level Special Topics

Spring: 9 units

This course will offer an overview of the evolution of the European Union, from the 1951 Treaty of Paris to the present day, including study of the major institutions of European governance and pivotal issues in the economic and political spheres. Special emphasis will be given to EU cultural initiatives, regionalism and language policy. The course will draw heavily on current documentation, including the press, film and video, and the wealth of Web resources, to supplement a required text and handouts. Outside guest lecturers will contribute in areas of regional/national specialization. Prerequisite: 82-303 and 82-304 or Instructor permission for students seeking credit toward the French major. No prerequisites for non-majors.

82-407 The Arts in Society

Intermittent: 9,12 units

The number 82-407 is a repeating number that refers to a sequence of European Studies core courses entitled "The Arts in Society" followed by the course name: "Theaters of Love," "French Modernism," and "Theater and Lyric in the 20th Century". Each course in the 82-407 sequence explores a major theme of modernity and a range of works across cultures. Theater and Lyric in the 20th Century focuses on the dimensions of the subject after Romanticism. The course will concentrate on some of the works that transformed modern theater. Readings will include Brecht, Artaud, Beckett, Genet, and excerpts from a range of European and American authors. Works studied include plays, operas, songs, poems, and writings about avant-garde theater. We will view films, filmed performances, and adaptations by a number of directors, including Chaplin, Linder, Pabst, Genet, Brook, Prévert/Carné, Beckett, Renoir, Truffaut, Rivette, Godard, Antonioni, and van Peebles. The focus of the course is on the cultures of Western Europe and the U.S., with an emphasis on French, Anglo-Irish, and German works. All readings are in English. Three units of additional credit are available for students who wish to do some additional work in French. Total enrollment limited to 25.

82-408 Matisse, Chagall, Picasso & Their Contemporaries: Art & Museums on the Riviera

Intermittent: 9-12 units

This course examines the lives and work of the major 20th century artists (Chagall, Cocteau, Léger, Matisse, Picasso and Renoir) as well as some of their contemporaries who are prominently associated with the art of the Riviera. Considering the artists' personal stories, the course provides a "social art history" and a multidisciplinary focus which includes an understanding of the historic context, geographic setting, and artistic milieu in which these artists lived and worked, complemented by a conceptual exploration of what a museum is, its physical space and its role in society. The course will be taught in English with assigned readings and related assignments

in French for French minors and majors. *Prerequisite: None

*Students of French who want course credit toward the major or minor in French will register for an extra 3 units of coursework in French. In this case, prerequisites are completion of 82-303 or 82-304, or approval of the instructor.

82-410 Advanced Research in French Francophone Language and Culture

Fall and Spring: 9 units

In this course, students will study the core curriculum of the 82-305 course, which is to say, a focus on culture through language variation in spoken and written forms of French. Readings, videos, web use, and in-class conversations involve phonological and sociolinguistic aspects of the French language and language change; its use regarding different registers and regional languages within France; the question of social identity through language; immigration and generational issues; and an exploration of the distinctive francophone uses of the French language. In order to achieve these goals, students do personal work on improving their control of the French phonological system, and discuss current issues in France and francophone regions/countries by using multimedia tools available in the Modern Language Learning Resource Center (MLRC). For students in the advanced level of this 305 core curriculum, a research project showing the application and intellectual development of one or several of the concepts described above is required. The project involves a written work of a minimum of 15 pages plus bibliography and a 10-minute oral presentation to the class, both in French. Prerequisites: 82303 or 82-304

82-415 Literature, Art, & Film: Feminine/Masculine

Fall: 9 units

A series of innovative courses exploring French and Francophone literature and culture through a thematic or conceptual focus. Some courses are offered in the context of European Studies as well. Some course topics include Writing and Viewing the Other: French and Francophone Approaches to Theater, Fiction, and Film; Feminine/Masculine: Images of Gender Identity in French Modernism; Images of Paris: Art, Gender, and Cultural Identity in the Capital of the Nineteenth Century; Staging French Modernity: The Twentieth Century; Writing, Painting, Monument: Portraits in French Modernity; and, Emerging Literature: Twentieth-Century Francophone Writing. Prerequisite: 303 and 304 or permission from the Instructor.

Prerequisites: 82303 or 82304 or 82305

82-416 Topics in French and Francophone Studies

Spring: 9 units

A series of innovative courses exploring French and Francophone literature and culture through a thematic or conceptual focus. Some courses are offered in the context of European Studies as well. Some course topics include Writing and Viewing the Other: French and Francophone Approaches to Theater, Fiction, and Film; Feminine/Masculine: Images of Gender Identity in French Modernism; Images of Paris: Art, Gender, and Cultural Identity in the Capital of the Nineteenth Century; Staging French Modernity: The Twentieth Century; Writing, Painting, Monument: Portraits in French Modernity; and, Emerging Literature: Twentieth-Century Francophone Writing. Prerequisite: 303 and 304 or permission from the Instructor.

Prerequisites: 82303 and 82304

82-420 German Classical Literature

Intermittent: 9 units

This course, conducted entirely in German, provides a basic introduction to the literature of Enlightenment, Sturm und Drang, and classicism in Germany during the second half of the eighteenth century and at the beginning of the nineteenth century. Classical literature appeared in Germany at a later date than in the other major European countries; for this reason German classical literature tends to be more accessible linguistically to contemporary readers than some other classical literatures. The course will begin with the remarkably lucid and relevant work of Lessing, in particular his plays Emilia Galotti and Nathan der Weise--both programmatic statements of Enlightenment rationality and critical bourgeois consciousness. We will then move on to the brief but important Sturm und Drang period, exploring Goethe's revolutionary novel Die Leiden des jungen Werther, Schiller's radical drama Die Räuber, and Lenz's disturbing play Der Hofmeister. The focus will be on Sturm und Drang as a uniquely German phenomenon, and on the reasons for its rapid development and quick demise. Our exploration of classical literature will culminate with Goethe's Faust I, one of the great masterpieces of western literature and probably the most celebrated and influential work in the German literary canon. We will also devote time to close reading and aesthetic appreciation of some of Goethe's most beautiful poems. An examination of Schiller's

letters *Über die ästhetische Erziehung des Menschen* will round out our exploration of German classicism as an idealistic aesthetic movement. Students will be asked to complete five brief writing assignments over the course of the semester, and to take midterm and final examinations. Prerequisite: Completion of 82-325 or approved equivalent.

82-421 German Literature of the Nineteenth Century
Intermittent: 9 units

This course, entirely in German, focuses particularly on short fiction such as *Märchen* or fairy tales. The nineteenth century was the heyday of Romanticism, in which authors told tales of the fantastic stories like E. T. A. Hoffmann's *The Nutcracker* and the *Mouse King*, which was subsequently turned into a famous Christmas ballet by the Russian composer Peter Ilyich Tchaikovsky. Germany is particularly famous for its Romantic culture, and in fact tens of thousands of people all over the world get married every year to the music of German Romantic composers like Richard Wagner and Felix Mendelssohn (*Here Comes the Bride* and the *Wedding March*, respectively). For many, Romanticism achieved its purest expression in Germany. Students will be asked to participate actively in discussions of the reading, to write a series of short papers, to lead classroom discussion on one day, and to complete a final project of their choice. Prerequisite: Completion of 82-325 or approved equivalent.
Prerequisites: 82325

82-422 German Literature of the Early Twentieth Century
Intermittent: 9 units

From its inception in 1871, The Second German Empire promised to be an industrial, cultural and military powerhouse on the continent of Europe. But when the hand of the Iron Chancellor, Otto von Bismarck, was removed from the helm by Kaiser Wilhelm II in 1890, the "New Germany" charted a course that would lead to a catastrophic conflict with its neighbors to the west (England and France) and to the east (Russia). This course exams works by some of the major authors of this period (Mann, Wedekind, Hauptmann, Rilke, Kafka) as well as modern film adaptations of their works. Readings will also include seminal thinkers such as Nietzsche, Freud, Marx and Einstein. And, we will engage the visual arts through a survey of the German Expressionists. The purpose of this course is to examine a wide variety of "cultural artifacts" against the backdrop of the political, social, and economic currents of the period. Prerequisite: Completion of 82-325 or approved equivalent.
Prerequisites: 82325

82-424 The New Germany
Intermittent: 9 units

This course explores contemporary culture in German speaking Central Europe. Prerequisites: Completion of 82-325 or approved equivalent.

82-425 Topics in German Literature and Culture
Intermittent: 9 units

A series of innovative courses exploring German literature and culture through a thematic or conceptual focus. A recent course topic includes Germany During the Second Empire. Prerequisite: Completion of 82-325 or approved equivalent.
Prerequisites: 82325

82-426 Topics in German Literature and Culture
Intermittent: 9 units

A series of innovative courses exploring German literature and culture through a thematic or conceptual focus. Prerequisite: Completion of 82-325 or approved equivalent.
Prerequisites: 82323 or 82324 or 82325

82-427 Nazi and Resistance Culture
Spring: 9 units

"How could the land of Goethe and Beethoven also have produced Hitler and the Holocaust?" This is a question that has frequently been posed about Germany. Germany has arguably been the dominant country in Western musical development since the sixteenth century; it has also witnessed an extraordinary flowering of literature, philosophy, and the visual arts. This course, conducted entirely in German exclusively for students with superior German-language skills, will explore what happened to German culture from 1933 to 1945. In particular, it will examine the Nazi assault on modern (or "degenerate") art and the artistic response of the German and foreign resistance to Nazi tyranny. Arts explored will include literature, film, music, and the visual arts. We will read from the works of a variety of writers, including Ádon von Horvath, Anna Seghers, Bertolt Brecht, Adolf Hitler, Albert Speer, Hanns Johst, Paul Celan, and Wilfrid Bade. Film will also play a major role in the course, and students will be required to view (outside of class)

and discuss six Nazi-era films, including Veit Harlan's infamous anti-Semitic *Jud Süß*, Rolf Hansen's Nazi musical romance *Die große Liebe*, and Charlie Chaplin's *The Great Dictator*. Students will be required to lead a classroom discussion, to write a major essay, to write a *Protokoll*, to complete all required readings, and to participate actively in classroom discussion, in German. Prerequisite: Completion of 82-325 or approved equivalent.
Prerequisites: 82325

82-428 History of German Film
Intermittent: 9 units

Throughout the twentieth century, the German cinema has consistently been one of the most productive and creative national cinemas in the world. During the first three decades of the twentieth century, some of the great classics of silent cinema were produced in Germany. Many of these films were highly influential throughout the world, particularly in the United States, where some of the great German directors and film stars settled in the late 1920s and 1930s, frequently for political reasons. In the late 1960s and 1970s, German directors developed a unique filmic style based on an attempt to come to terms with the German past and on a critique of Hollywood's domination of the world entertainment industry. The history of German cinema closely reflects the history of the German nation in the twentieth century. The course, taught in German, will cover this entire history, from 1895 to the present, with a particular emphasis on the Weimar period (1918-1933) and the renaissance of "New German Cinema" in the 1970s. Also considered will be the cinema of the Second and Third Empires, the cinema of the German Democratic Republic, and the resurgence of German comedy in the 1990s. Directors studied include Friedrich Murnau, Fritz Lang, Leni Riefenstahl, Rainer Werner Fassbinder, and Wim Wenders. Prerequisite: Completion of 82-325 or approved equivalent.
Prerequisites: 82324

82-429 German Reading and Translation Workshop: Undergraduate
Intermittent: 9 units

This course will explore different models of translation. Individual and group work will focus on translation of literary pieces, journal articles, critical essays, materials from the internet and other sources. The workshop will also offer an advanced-level grammar and stylistics review, a vocabulary builder and increased exposure to German language and culture. Prerequisite: Completion of 82-323 or 82-324 or permission of the Instructor.
Prerequisites: 82324

82-431 China and the West
Intermittent: 9 units

This course takes an interdisciplinary approach to study the multi-faceted relationship between China and the Western world from Marco Polo's time to the present. The focus will be on how people in China and the West imagined each other in different times of history and in what ways some historical figures and concepts as well as cultural practices, such as Marco Polo, Boxer Rebellion, China's recent economic success, Chinese religions and art, etc., are interpreted differently from Chinese and Western perspectives. Students are expected to reach a deeper understanding of the complexities of cultural interactions and their implications for the diverse world in which we now live. The students will read a rich collection of scholarly writings, and the class will be conducted primarily in discussion format. This is a variable unit course (9, 12). Students who take this class for 12 units will be required to do extra reading and writing in Chinese and instructor's pre-approval is needed.
Prerequisites:

82-433 Topics in Contemporary Culture of China
Fall: 9 units

This fourth-year Chinese course aims at providing students with the opportunity to learn authentic Chinese used in various forms of Chinese media. Through close contact with integrated and annotated authentic TV news broadcasts and newspaper reports, editorials and feature articles on topics related to various social issues of contemporary China, students are expected to make a breakthrough in their comprehensibility of Chinese media. Class discussion, debates and presentations on various topics will be the major forms of activities followed by essay writing to expose students to the contemporary culture of China and prepare them to function in various ways in the real situation of China in the future. Prerequisite: 82-332 or approved equivalent.
Prerequisites: 82332

82-434 Studies in Chinese Traditions
Spring: 9 units

FALL 2008 Course description: This course aims at helping students to obtain a general idea of Chinese history from 5000 years

ago, understand the basic philosophical ideas of Confucianism and Daoism so that they will be aware and understand how Confucianism and Daoism have influenced the traditional Chinese ways of thinking. Students will also learn to use Chinese to analyze and comment both orally and in written form the pros and cons of the traditional Chinese ways of thinking and the differences between people's ways of thinking in Chinese culture and those in another culture. Materials for this course will be selected from classical works on Confucius teachings, classical poems, modern prose writings, excerpts from Chinese novels, etc. The themes will focus on Chinese history, basic philosophies of Confucianism and Daoism and their influence on the ways of thinking in the daily life of Chinese. Specifically the materials will deal with such issues as traditional Chinese views on study and education, career, family, human relations with nature, self-cultivation and women.
Prerequisites: 82332

82-435 Advanced Reading in Chinese
Intermittent: 9 units

Prerequisites: 82324

82-436 Introduction to Classical Chinese
Intermittent: 9 units

This course is designed for students who have reached the advanced level of Modern Chinese and would like to promote their knowledge and skills in reading Classical Chinese, a language shaped in the latter half of the first millennium B. C. which still persists as a living medium of expression today. The course aims to introduce students to the basic syntactic patterns of Classical Chinese and the most frequently used Classical Chinese vocabulary. In the course, we will read representative selections from ancient Chinese texts, chosen for their historical value, beauty, and influence on later writers. With this knowledge and training, students will be sufficiently equipped to read the Chinese Classics and will gain a deeper understanding of the history of Chinese civilization, culture and language. Moreover, knowledge of Classical Chinese will help students read and understand sophisticated modern Chinese texts, which make frequent use of Classical allusions and constructs.
Prerequisite: 82-332 or approved equivalent

82-441 Studies in Peninsular Literature and Culture
Intermittent: 9 units

A sociocritical approach to the study of Spanish literature. A survey of representative authors considered in the context of the cultural heritage of Spain. Prerequisite: Completion of 82-345 or permission of Instructor.
Prerequisites: 82345

82-442 Analysis of Spoken Spanish
Intermittent: 9 units

This course is an introduction to Spanish Linguistics. The main goal of the course is to provide students with the opportunity to learn the tools of linguistic analysis and to apply them to the study of Spanish. Attention will be given to different levels of analysis in linguistics including phonetics, phonology, morphology, and syntax. Class time will be divided between lecture, problem-solving exercises, and discussion. Students will have the opportunity to write and present a research paper in specific areas of Spanish linguistics according to their interests. Prerequisite: Completion of 82-345, or permission of the instructor.
Prerequisites: 80280 or 82343

82-443 Spanish Reading and Translation Workshop
Intermittent: 9 units

This course is of interest to advanced Spanish majors and minors as well as non-specialists seeking to develop reading and translation skills in Spanish. The course will be conducted as a workshop to allow different populations to participate in the class. There will be an emphasis on both individual and group work, different theoretical models of translation and literary pieces, journal articles, critical essays and materials from Internet news services and bulletin boards. For students with advanced Spanish background (major & minors), the reading and translation workshop will offer an advanced-level grammar and stylistics review, a vocabulary builder and increased exposure to Hispanic language and culture. Prerequisite: For Hispanic studies majors and minors, completion of all 300-level coursework or permission of the instructor.
Prerequisites: 82342 or 82343 or 82344 or 82345

82-444 The Structure of Spanish
Intermittent: 9 units

This course investigates the processes that contribute towards the unification and fragmentation of Spanish as a single language. Some of the specific topics discussed include: Spanish language

history, distribution of Spanish throughout the world, processes of standardization, variation in phonology, morpho-syntaxis, lexis, pragmatic functions of language (e.g.: politeness, forms of address, etc.), and Spanish in contact with other languages. Students will develop their discourse analytical skills through practical language activities and field projects. They will improve their ability to express in academic Spanish through class discussions, presentations and by producing a final research paper. Prerequisites: Completion of 82-345 or permission of the instructor.
Prerequisites: 82342 or 82343 or 82344 or 82345 or 82346

82-445 U.S. Latino Literature
Intermittent: 9 units

This course proposes to problematize socio-political and historical-cultural issues concerning U.S. Latinos and Hispanic immigrants in the United States. This will involve the analysis and application of assimilation, transculturation and bilingualism theory, and rhetorical translational problematics of the material under examination. Also of interest will be an ongoing class discussion of Latinos/Hispanics in history, the media, entertainment, politics and education. We shall also discuss the "borders," geographical, political and societal, that may or do exist between U.S. mainstream society, Latinos and Hispanic immigrants and strategies employed by hyphenated-Americans for overcoming, subverting or undermining this situation. Materials for the course will include literature, film, essays and music by and about Latinos and Hispanics in the United States.
Prerequisite: Completion of 82-345 or permission of the instructor.

82-446 Political Drama of Spain
Intermittent: 9 units

This course will focus on political drama from Spain. The themes of tyranny, oppression, freedom, and honor will be examined in works by Spanish playwrights such as Miguel de Cervantes, Lope de Vega, Calderón, the Duke of Rivas, Alfonso Sastre, and Antonio Buero Vallejo. Special attention will be given to the social and historical contexts of the works. Films and critical articles will complement the study of the primary texts. Readings, class discussions, and all assignments will be in Spanish. Prerequisite: Completion of 82-345 or permission of the instructor.

82-450 Advanced Research in Hispanic Language and Culture
Fall and Spring: 9 units

This course permits in-depth, 400-level study in the following courses: 82-342 Spain: Language and Culture, 82-343 Latin America: Language and Culture, and 82-344 U.S. Latinos: Language and Culture. Students will meet with the regularly scheduled 300-level class, read additional texts, and produce research assignments as agreed upon by the Instructor and student. Focus is on a deeper understanding and individualized research of the course topics.
Prerequisite: By permission of the instructor only.

82-451 Studies in Latin American Literature and Culture
Intermittent: 9 units

A sociocritical approach to the study of Latin American literature and a survey of representative authors considered in the context of the cultural heritage of Latin America. Prerequisite: Completion of 82-345 or permission of Instructor.
Prerequisites: 82345

82-452 The Latin American Fin de Siglo: Modernity, Modernismo, and Underdevelopment

Intermittent: 9 units
In this course, we shall use print media, film, music, dance, fashion, diet, art and architecture to study the anthropological and cultural ramifications of politico-economic and socio-cultural events surrounding the turn-of-the-century eras (1880-1920 and 1980 to the present) in Latin America and relate them to the current fin de siglo and millennium. We shall analyze the effects of the increasingly globalized nature of the world economy in order to understand the effects of U.S. and European interference and investment in Latin America and how these two world powers have shaped its cultural production in the early and late 20th century. Prerequisite: Completion of 82-345 or permission of the instructor.
Prerequisites: 82301 or 82303 or 82304 or 82324 or 82326 or 82331 or 82332 or 82342 or 82343 or 82344 or 82345 or 82346 or 82372 or 82385 or 82386 or 82392 or 82399

82-453 Voices from Within: The Crisis of Latin American Identity
Intermittent: 9 units

An introduction to the complex fabric of Andean, Southern Cone, Mexican and Caribbean cultures through their literatures, with supplementary materials from the arts (music, film, photography, painting, architecture, etc.) and religion. The course will focus on issues of identity by examining the literary and artistic (self) representation of Indigenous, African and European people in the

specific context of miscegenation and its unique sociopolitical, economic and cultural origins and implications. Prerequisite: Completion of 82-345 or permission of the instructor.

82-454 The Hispanic Caribbean: Rhyme, Reason and Song
Intermittent: 9 units

This course will cover a broad range of topics, all of which will shed light on how to define the identity of the Hispanic Caribbean, its history and reality, and its cultural expression. Texts for this course will primarily include literary and non-literary pieces (chronicles, historical and political essays, legal treatises, poetry, and song lyrics), and photography, music, art and food. Some of the topics that will be covered through the varied literary, legal, and musical texts are a profile of the Caribbean region, the history of colonization, the institutionalization of race, color and difference, slavery, the sugar plantation and its shaping of regional history and economics, tobacco, sugar and coffee culture, religious syncretism, the urban/rural experience, the Trujillo dictatorship in the Dominican Republic, the Puerto Rican dilemma-territory, statehood or independence, the Cuban revolution, contemporary Hispanic Caribbean and U.S. Latino expressions. Prerequisite: Completion of 82-345 or permission of the instructor.
Prerequisites: 82345

82-455 Topics in Hispanic Studies

Fall: 9 units

A series of inquiries into an aspect of Hispanic literature, such as a literary movement, a genre, a theme or the work of a single author (e.g., Knights, Rogues, Saints/Caballeros, PÁcaros, Santos; Latin American Short Story and Essay: Literary Mediations; Portrayals of Family Life in Twentieth-Century Spain; The Other in Latin American Literature and Film). Prerequisite: Completion of 82-345 or permission of Instructor.
Prerequisites: 82345

82-456 Literature and Revolution in 20th Century Central America
Fall and Spring: 9 units

A series of inquiries into an aspect of Hispanic literature, such as a literary movement, a genre, a theme or the work of a single author (e.g., Knights, Rogues, Saints/Caballeros, PÁcaros, Santos; Latin American Short Story and Essay: Literary Mediations; Portrayals of Family Life in Twentieth-Century Spain; The Other in Latin American Literature and Film). Prerequisite: Completion of 82-345 or permission of Instructor.
Prerequisites: 82345

82-457 Contemporary Latin American Texts: Revision, Rewriting and Representation

Intermittent: 9 units

This course is an overview of contemporary Latin American "texts" dealing with issues of historical representation, autochthonous heritage, popular culture and gender roles. By "texts" we shall understand conventional and unconventional literary material, film, art, slides and music. The course will explore formal and "rhetorical" problematic, as well as the relationship between fiction and imaginary solutions to real cultural and political conflicts. We shall consider the functions of myth and history in Latin American society and the revisionist role of contemporary texts. We shall also examine the categories and implications of historicized fiction and 'literaturized' history with particular attention to the power dynamic present in the segregation of the traditional disciplines which are History and Literature, conceived institutionally as reality and fiction, respectively. Prerequisite: Completion of 82-345 or permission of the instructor.

Prerequisites: 82342 or 82343 or 82344 or 82345 or 82346

82-473 Topics in Japanese Studies

Intermittent: 3-12 units

Under this course title, a broad range of topics relating to Japan and the Japanese people are dealt with through multiple perspectives e.g., (cross-)cultural, social, generational, developmental, linguistic, and historical. When offered, the course focuses on a single topic and thus students may repeat with a different topic. Topics currently offered under the course title are "Changing Cultural Icons – Samurai, Kamikaze, and Totoro –", "Japanese Family through Cinema", and "Youth Culture". Further topics will be added as they become available. This course is offered intermittently in fall.
Prerequisites: 82-372 or approved equivalent.

82-474 Topics of Japanese Studies

Intermittent: 9 units

Under this course title, a broad range of topics relating to Japan and the Japanese people are dealt with through multiple perspectives e.g., (cross-)cultural, social, generational, developmental, linguistic, and historical. When offered, the course focuses on a single

topic and thus students may repeat with a different topic. Topics currently offered under the course title are "Changing Cultural Icons – Samurai, Kamikaze, and Totoro –", "Japanese Family through Cinema", and "Youth Culture". Further topics will be added as they become available. This course is offered intermittently in spring.
Prerequisites: 82-372 or approved equivalent.
Prerequisites: 82373

82-476 Japanese Discourse Analysis

Fall: 9 units

Through practical language activities, interviews, and field projects, students will develop refined Japanese discourse analytical skills. The course provides opportunities for students to acquire a high proficiency of communication skills both in the spoken and the written forms focusing on topics such as formal speech, job interviews, and business writing, while increasing exposure to Japanese culture. Formality, politeness, and gender differences are some of the major topics discussed in this course as well as how speaker's perspectives and attitudes are reflected within language expressions. Prerequisites: 82-372 or approved equivalent.
Prerequisites: 82273 and 82372

82-477 Japanese Conversation Analysis

Spring: 9 units

Through analysis of various registers of the Japanese Spoken language, this course aims to provide analytical tools for Japanese conversational analysis and to provide opportunities to students to practice high proficiency level of oral communication skills such as formal speech, job interviews, and business communication. Formality, politeness, and gender differences are some of the major topics discussed in this course as well as speakers' perspectives, attitudes and emotions. This course is offered in Japanese.
Prerequisite: 82-372 or equivalent.
Prerequisites: 82372

82-480 Social and Cognitive Aspects of Bilingualism

Intermittent: 9 units

This course introduces students to the nature and extent of bilingualism in individuals and diverse communities in the US and abroad, with an emphasis on the social, historical and political forces that shape the language varieties and abilities of bilinguals. There is also a brief exploration of the psycholinguistic features that characterize bilingual individuals. It also addresses the challenges and opportunities that bilingualism poses for multilingual societies and individuals. Students will develop their knowledge and critical analysis skills of bilingualism through readings, group discussions, field projects and a research paper. Pre-requisites: Students must have completed 82-280, 82-180, 82-384, 82-382 or by permission of the instructor.

82-481 Research Methods in Second Language Acquisition

Spring: 9 units

Introduces students to research methodology as it applies to language learning and language teaching. An examination of different approaches currently used in Second Language Acquisition (SLA) research ranging from experimental studies to case studies. The goal is to develop an ability to critically evaluate, design and implement sound SLA research. Prerequisite: None.

82-483 Topics in Modern Languages

Intermittent: Variable units

Introduces students to research methodology as it applies to language learning and language teaching. An examination of different approaches currently used in Second Language Acquisition (SLA) research ranging from experimental studies to case studies. The goal is to develop an ability to critically evaluate, design and implement sound SLA research. Prerequisite: None.

82-484 Language Assessment

Spring: 9 units

Theoretical and practical study of aspects of language testing. Purposes and types of language tests are examined in relation to theories of language use and language teaching goals. Testing practices and procedures related to language research and language teaching are also discussed. The course also includes the planning, writing, and administration of tests, and basic test analysis.
Prerequisite: None.

82-485 Topics in Modern Languages, Literature and Cultures

All Semesters: 3,6,9 units

82-486 Independent Study in Languages

Intermittent: 9-18 units

An opportunity for students who wish to complement their course work at the 400-level and pursue further advanced study. In conjunction with a faculty member, students will arrange a program of study to explore aspects of the target language and culture. Prerequisite: Permission of the Instructor.

82-487 Writing in a Second Language

Intermittent: 9 units

This course will provide students with a comprehensive understanding of second language (L2) writing by surveying fundamental issues and the relations between empirical research, alternative theoretical perspectives, and pedagogical practices in L2 writing. Topics include text, psychological, and social models of L2 writing instruction and learning. Students are expected to carry out a research project on a focused topic of their choosing concerning L2 writing. Prerequisites: 82-382 or permission of the Instructor. Prerequisites: 82383 or 82783

82-489 Service Learning in the Community

Intermittent: 9-12 units

This is a community-based research (CBR) course for 400-level students of Modern Languages who wish to bridge service and action research. The course provides an experiential component for advanced students of Modern Languages. Such a component will allow ML students to use their second language and culture while acquiring or honing their research skills. CBR helps bridge the gap between university and community life to facilitate the development of life-long learning habits and humanistic citizenship. ML students and faculty will jointly design and create ways in which to 'give back to' the community under study, which will be chosen based upon the language, culture and/or history of a specific community. Some examples of this would be to: document a community's history or culture, establish an ongoing link between the university and the community, or identify and solve a community problem. Using both English and their target language, students in this course may participate in historical, ethnographic and cultural research; ethnographic fieldwork; and problem solving around the question of how best to identify a particular linguistic/cultural community and document, interpret, preserve and disseminate its history and culture. Class activities may include group, pair and independent reading and research; group and pair travel; group, pair and one-on-one interaction with community members; public presentations; photography/filming/scanning; webpage and document design; and different kinds of writing in both English and the target language. Prerequisites: 82-345 or permission of the instructor.

82-491 Literature, Politics and Film in Russia & East Europe Today

Intermittent: 9,12 units

This course aims to familiarize the student with the cultural geography of contemporary East Europe, including Russia. Visual texts serve to outline the power politics that have shaped East European and Russian/Soviet cultures from World War II to the present, dramatic day, while verbal texts reveal a range of personal responses to current crises affecting national identity, human rights, gender roles, and the natural environment. While the first of these is the predominant concern of the course, the other three attract a good deal of attention as they take shape in the modes of cultural discourse by which national identities are formulated. The course seeks to sample this discourse mainly in fictional literature and feature film; however, a small number of nonfiction essays and documentary films are seen to demonstrate the breakdown of traditional genres that characterizes intellectual production in times of political flux. Prerequisites: None for 9 units; an additional 3 units, requiring permission of the instructor, can be earned for work done in Russian.

82-492 The Historical Imagination in Nineteenth-Century Russian Literature

Intermittent: 9,12 units

Pushkin, Gogol, Lermontov, Turgenev, Dostoevsky and Tolstoy all ruminated upon their nation's historical destiny. This course aims to describe the role played by imagination in these authors' efforts to break from Russia's past a vision of her future. Emphasis is placed upon the figurative operations of language that allow narrative to function as a guidepost to a collective mission and a map of the individual's location within the projected historical scheme. Lecture and discussion formats are combined at each class meeting. Written papers, oral presentations, and participation in discussions are required, as are reading assignments of approximately 200 pages per week. The course is offered in English, three hours per week, for 9 units, for which there are no prerequisites. None for 9 units; an additional 3 units, requiring permission of the instructor, can be earned for work done in Russian. Prerequisites: None. Prerequisites: 82292

82-493 Joseph Brodsky in Context

Intermittent: 9 units

The purpose of the course is to explore the biographical facts, political circumstances and cultural histories underlying the paradoxical and poignant trajectory of Joseph Brodsky's outstanding achievements as poet, playwright, essayist and spokesman for literature's value to ethics and education. His work is deeply rooted in the artistic efflorescence of the "Silver Age" in twentieth century Russian poetry, but takes equal inspiration in the metaphysical poetry of England's Renaissance and Modern ages. To read Brodsky is thus to read Anna Akhmatova, Marina Tsvetaeva and Osip Mandelstam, on the one hand, and John Donne, George Herbert, T.S. Eliot, and W.H. Auden on the other. Works by and about these authors as well as Brodsky thus comprise the reading matter of the course. Poetry, essays and literary criticism are read with a view toward textual explication as a starting point for engaging the larger issues by which any literature subsists. To study the career of this most unusual writer in its bilingual, bicultural context is to confront the most fundamental questions about the means by which cultures are empowered and the reasons for which they succeed or fail to coexist in any given place and time. The language of the course is English for all readings, lectures and discussions. No knowledge of Russian is required, but those who can are invited to read in Russian as well. The course follows a predominantly seminar format. Reading and writing assignments are required, as is participation in classroom discussion. Prerequisite: None.

82-499 Alternative Break Projec (Language)

Fall and Spring: 3, 6 units

This course provides advanced ML language students and non-ML students enrolled in an Alternative Break student trip project the opportunity to earn credit by engaging in "connected" modes of knowing, by identifying and analyzing a problem, and developing plans for short-term and sustainable solutions, reflecting, and creating and disseminating an informational and interpretive website and print materials about their experience. Students will also bring to bear or gain experience in non-academic skills/talents/interests in areas like photography, image editing, video production, writing, design, website development, sound recording, and art, etc., by doing community service under the auspices of Carnegie Mellon University's Alternative Break program. Students will earn three (3) units for full participation and fulfillment of course requirements. With the approval of the faculty facilitator, an additional three (3) units may be earned by completing an additional assignment.

82-501 Special Topics: French

Fall: 3-12 units

Restricted to language majors who wish to go beyond the regular course offerings in French. Group or individual study in a subject area approved by the Instructor. Prerequisite: Permission of the Instructor.

82-502 Special Topics: French

Spring: 3-12 units

Restricted to language majors who wish to go beyond the regular course offerings in French. Group or individual study in a subject area approved by the Instructor. Prerequisite: Permission of the Instructor.

82-505 Undergraduate Internship

Intermittent: 1-18 units

Approved upper-class language majors may receive credit in connection with work experience related to language learning and language use outside of the classroom setting. As a rule, this experience takes the form of work involving language use or research related to language study at off-campus sites or in the Department. Work or research must be done using the language of study. For off-campus internships, there must be an on-site supervisor appointed to collaborate with the faculty advisor in the final evaluation of the student's work and progress. The student will be responsible for three written reports evaluating the non-classroom experience with the language of study and several other criteria. Students must obtain prior approval for proposed work. Prerequisite: Permission of target faculty member and the ML internship advisor.

82-521 Independent Study

Fall: 3-12 units

Restricted to language majors who wish to go beyond the regular offerings in German. Group or individual study in a subject area approved by the Instructor. Prerequisite: Permission of the Instructor and a 400-level course.

82-522 Special Topics: German

Spring: 3-12 units

Restricted to language majors who wish to go beyond the regular offerings in German. Group or individual study in a subject area approved by the Instructor. Prerequisite: Permission of the Instructor and a 400-level course.

Prerequisites: 82427 or 82428 or 82429 or 82430 or 82431 or 82435 or 82436 or 82437 or 82438

82-541 Special Topics: Spanish

Fall: 3-12 units

Group or individual study in an approved subject area outside of the regular course offerings. Prerequisite: Completion of a 400-level course and permission of an instructor. Restricted to language majors.

82-542 Special Topics: Spanish

Spring: 3-12 units

Group or individual study in an approved subject area outside of the regular course offerings. Prerequisite: Completion of a 400-level course and permission of an instructor. Restricted to language majors.

82-561 Special Topics: Italian

Fall: 3,9,12 units

An option for students who wish to go beyond the regular offerings in Italian. Group or individual study in a subject area approved by the Instructor. Prerequisite: Permission of the Instructor.

82-562 Special Topics: Italian

All Semesters: 3,6,9,12 units

An option for students who wish to go beyond the regular offerings in Italian. Group or individual study in a subject area approved by the Instructor. Prerequisite: Permission of the Instructor.

82-571 Special Topics: Japanese

Fall: 3-12 units

Designed for students of Japanese who wish to go beyond the regular offerings in Japanese. Most suitable for students who have their own ideas for research projects on Japan-related topics of their interest. Students may read Japanese materials (e.g., books, newspapers, magazines, WebPages) and/or speak to native Japanese speakers in Japanese to gather information, and write up findings of their projects in Japanese. Students work on their own projects individually but under the Instructor's guidance. Prerequisites: Permission of the Instructor.

82-572 Special Topics: Japanese

Spring: 3-12 units

Designed for students of Japanese who wish to go beyond the regular offerings in Japanese. Most suitable for students who have their own ideas for research projects on Japan-related topics of their interest. Students may read Japanese materials (e.g., books, newspapers, magazines, WebPages) and/or speak to native Japanese speakers in Japanese to gather information, and write up findings of their projects in Japanese. Students work on their own projects individually but under the Instructor's guidance. Prerequisites: Permission of the Instructor.

82-580 Senior Seminar in Modern Languages

Spring: 3 units

This mini-seminar for majors in Modern Languages focuses on general issues in second language learning. It provides an integrative and culminating experience for students as they complete their studies. The course includes consideration of language learning and language maintenance, the role of second languages in American life, issues of linguistic and cultural diversity in the United States today and discussions of multiculturalism throughout the world. The goal of the seminar is for students to reflect upon their language learning experience and to discuss the role that a second language plays in their own lives and in American society today. Co-requisite: Open only to Modern Languages Majors.

82-591 Modern Languages Honors Thesis

Fall: 9 units

Modern Language majors with outstanding academic records and intellectual promise will be given the opportunity to undertake original research under the direction of an individual faculty member. Students and faculty select the research topics. Prerequisites: Senior standing; a 3.5 QPA in one's language major; a 3.25 QPA overall; permission of the Department Head and approved entry into the College's Honors Program.

82-592 Modern Languages Honors Thesis

Spring: 9 units

Modern Language majors with outstanding academic records and intellectual promise will be given the opportunity to undertake original research under the direction of an individual faculty member. Students and faculty select the research topics.

Prerequisites: Senior standing; a 3.5 QPA in one's language major; a 3.25 QPA overall; permission of the Department Head and approved entry into the College's Honors Program.

82-599 Russian Studies Thesis

Intermittent: 3-6 units

This course consists of researching and writing the thesis that is required of Russian Studies majors. It is generally completed during the senior year. See Russian Studies Major description. Work is done individually, under the guidance of a Russian Studies advisor. Prerequisite: Permission of the Instructor.

Psychology**85-100 Introduction to Intelligence in Humans, Animals and Machines**

Fall: 9 units

A practical as well as theoretical introductory course aimed at increasing the students learning, problem solving, decision making and critical thinking skills. The course will begin by contrasting between intelligent and instinctive behaviors. It will then examine the roles that perception, learning, curiosity, problem solving, decision making, and language play in enabling humans and other animals to behave intelligently. Special attention will be paid to language in animals and to the nature of creativity. Finally, the course will examine the similarities in and differences between animals (including humans) and machine intelligence.

85-102 Introduction to Psychology

Spring and Summer: 9 units

This course examines major areas of scientific psychology in some depth, the attempt being to develop basic models of our behavior and thought that explain wide areas of our functioning. The primary focus is on the areas of neural and motivational control of behavior, memory and thought, social interaction, and psychological development. Specific topics within these areas include brain function, motivational control systems, learning, cognitive and perceptual information processing, problem solving, obedience and conformity, social interaction, emotion, attitude consistency and change, how our social, cognitive and language functions develop, the importance of childhood to adult functioning, and psychopathology. In addition to the lecture, the course includes a weekly recitation section meeting and weekly short WEB-based laboratory experiences in which students get to perform actual experiments, interpret real data, and experience many psychological phenomena.

85-211 Cognitive Psychology

Fall and Spring: 9 units

How do people perceive, learn, remember, and think? This course will consider perception, language, attention, learning, memory, reasoning, and decision making. Experimental findings and formal models will be discussed in each part of the course.

85-213 Human Information Processing and Artificial Intelligence

Fall: 9 units

This class will review various results in cognitive psychology (attention, perception, memory, problem solving, language) and use of artificial intelligence techniques to simulate cognitive processes. Prerequisites: 15211

85-219 Biological Foundations of Behavior

Fall: 9 units

This course will provide students with a general introduction to the underlying biological principles and mechanisms which give rise to complex human cognitive, perceptual and emotional behavior. Topics to be covered include: the anatomical structure of nerve cells and how they communicate, properties of brain organization and function, processing in sensory and motor systems, biological characteristics of human cognition, and neural and hormonal influences on health and emotion. This course will focus on how emerging methods and approaches are beginning to make it possible for psychologists, computer scientists, and biologists to gain an integrated understanding of complex behavior.

85-221 Principles of Child Development

Fall and Spring: 9 units

This course is about normal development from conception through adolescence. Topics include physical, perceptual, cognitive, emotional and social development. Students will learn facts about children at various points in development, theories about how development works, and research methods for studying development in infants and children. Students will be encouraged to relate the facts, theories and methods of developmental psychology to everyday problems, social issues and real world concerns.

85-241 Social Psychology

Fall and Spring: 9 units

The focus of this course will be on how peoples behavior, feelings and thoughts are influenced or determined by their social environment. The course will begin with lectures and readings on how social psychologists go about studying social behavior. Next, various topics on which social psychologists have done research will be covered. These topics will include: person perception, prejudice and discrimination, the nature of attitudes and how attitudes are formed and changed, interpersonal attraction, conformity, compliance, altruism, aggression, group behavior, and applications of psychology to problems in health care, law, politics, and the environment. Through readings and lectures on these topics, students will also be exposed to social psychological theories.

85-251 Personality

Intermittent: 9 units

The primary purpose of personality psychology is to understand human uniqueness--how and why it is that one person differs from others, in terms of the ways he or she thinks, feels, and acts. Students in the course will be exposed to several broad theoretical perspectives, each of which attempts to capture and understand the origins and consequences of individual distinctiveness from a slightly different vantage point. Included among these approaches are the dispositional, psychoanalytic, learning, phenomenological, and cognitive self regulation perspectives. This is a survey course and is intended to provide students with a broad background of theory and research in the area. Class meetings consist primarily of lecture, but there is some discussion too. In addition, classroom exercises will allow students to test their own personalities.

85-261 Abnormal Psychology

Fall and Spring: 9 units

The study of psychopathology is not an exact science; nor are there many clear-cut parameters with which to differentiate "normal" and "abnormal" behavior. This course will focus on learning about and understanding the range of behaviors which fall within the province of "abnormal" psychology. Its approach will be descriptive, empirical, theoretical and conceptual. Students will examine definitions of abnormality? in an historical and contemporary context, explore issues relevant to diagnosis and patient care, be introduced to various psychological diagnostic categories, and develop an appreciation of the range of treatments for these disorders.

85-310 Research Methods in Cognitive Psychology

Fall and Spring: 9 units

This is a course in which students develop the research skills associated with cognitive psychology and cognitive science. Students learn how to design and conduct experiments, and analyze and interpret the data they collect. The course covers a variety of experimental designs, e.g., factorial, Latin Squares. Analyses of response times, qualitative data, and signal detection are also covered. Cognitive modeling will also be discussed. Topics include mental imagery, memory, and perception. The class format consists of lectures, discussions and student presentations. You must have either taken 36-309 previously or 36-309 can be taken as co-req in Fall semester. In the Spring semester 36-309 is prereq. Prerequisites: 85211 or 85213 Corequisites: 36-309

85-320 Research Methods in Developmental Psychology

Fall and Spring: 9 units

This is a laboratory course, in which the student will have direct experience working with children, as well as writing research reports and designing and critiquing research in child development. The purpose of the course is to develop research expertise that will assist the student both in carrying out research and in evaluating the research of others. Special emphasis will be given to the unique methodological problems associated with the study of development. You must have either taken 36-309 previously or 36-309 can be taken as co-req in Fall semester. In the Spring semester 36-309 is prereq. Prerequisites: 85221 Corequisites: 36-309

85-340 Research Methods in Social Psychology

Fall and Spring: 9 units

This course is designed to provide students with the necessary knowledge to evaluate research, make transitions between theory and the operations that test the theory, and to design and carry out original research. Topics will include the nature of proof and causal inference, manipulation of independent variables, measurement of dependent variables, questionnaire design, experimental, and quasi-experimental, design and ethical issues involved in doing research. Survey, observational and experimental techniques as applied in both field and laboratory settings will be covered. Students will be expected to criticize completed research. They are also expected to design measures and complete their own original studies. During the course of the semester students will also be expected to design and carry out an original research project as well. You must have either taken 36-309 previously or 36-309 can be taken as co-req in Fall semester. In the Spring semester 36-309 is prereq. Prerequisites: 85241 or 85251 Corequisites: 36-309

85-352 Evolutionary Psychology

Intermittent: 9 units

This course will cover both the fundamentals of evolutionary psychology, including the theories of natural and sexual selection, with the overarching aim of providing an overview of the field at an advanced level. We will examine the relevance of evolutionary thinking to a range of psychological phenomena including problems of survival, long-term mating strategies, short-term sexual strategies, parenting, kinship, cooperative alliances, aggression and warfare, conflict between the sexes, and prestige, status, and social dominance. We will also examine evolutionary approaches to sensation and perception, development, consciousness, cognition, language, and abnormal behavior. Juniors and Seniors only or permission of instructor.

85-354 Infant Language Development

Intermittent: 9 units

While adults struggle to learn languages, almost all infants acquire language with seemingly little effort. This course examines infants' learning abilities and language milestones with a focus on several different theoretical accounts of language development, and the way empirical data can be used to assess those theories. The course is reading intensive, and evaluation will be based on both written assignments and oral participation. Prerequisites: 85221

85-355 Introduction to Cognitive Neuroscience

Intermittent: 9 units

Cognitive neuroscience is an emerging interdisciplinary field in which psychological, physiological, and computational methodologies are brought to bear in understanding the neural basis of cognitive processes. In this course, we will consider the application of methodologies such as physiological recordings from neurons in awake, behaving animals, functional neuroimaging (PET and fMRI) of normal subjects performing cognitive tasks, behavioral studies of brain-injured patients with selective cognitive deficits, and computational modeling of normal and impaired processing, in understanding cognitive domains such as high-level vision and attention, learning and memory, reading and language, meaning and semantics, and the organization and control of action. In each instance, the emphasis will be on how the application of converging methodologies, particularly those related to brain organization and function, leads to important insights into the nature of cognitive processes that would be difficult to obtain through any one conventional methodology alone. Prerequisites: 85211 or 85219

85-356 Music and Mind: The Cognitive Neuroscience of Sound

Intermittent: 9 units

This course will take a multidisciplinary approach to understand the neural systems that contribute to auditory perception and cognition, using music and speech as domains of inquiry. Students will master topics in acoustics, psychophysics, cognitive psychology, cognitive development, neurophysiology, and neuropsychology. The early part of the course will provide students with a common foundation in acoustics, signal processing, and auditory neuroscience. Later in the semester, the focus will turn to developing analytical skills through critical evaluation of primary-source experimental literature. Hands-on laboratories and homework sets in sound manipulation and experimentation also will constitute a means of learning about auditory cognitive neuroscience. Throughout, the focus will be upon understanding general cognitive and perceptual challenges in perceiving and producing complex sounds like speech and music. Topics may include biological vs. cultural influences, development in infancy, perception versus production, time perception, effects of experience on perceptual processing, comparative studies of

animals, attention, development of expertise, effects of brain damage, and emotional expression. Topics will be addressed from the perspective of cognitive neuroscience, in that we will attempt to understand the neural processes that give rise to auditory perception and cognition.
Prerequisites: (85211 or 85219 or 85370) AND (85310 or 85320 or 85340)

85-358 Pro-Social Behavior
Fall: 9 units

This course is an advanced seminar that focuses on social psychological research involving the examination of pro-social behavior. A heavy emphasis will be placed on classic research on helping (which investigates how, when, and why we help strangers), as well as the wide body of literature on social support (which investigates how we help, and seek help from, those who are closer to us). Research on both help-seeking and help-provision will be covered, as well as the implications of this type of pro-social behavior for relationships and health. The course also will cover research on other types of pro-social behavior such as empathy, altruism, forgiveness, and cooperation. This is an advanced seminar in which you will be expected to read original research articles and chapters on assigned topics and come to class prepared to discuss the material. Readings will consist of theoretical and empirical articles from psychology journals and related sources. Additional course requirements will involve short, weekly writing assignments, student presentations of research articles, and a written research proposal. Over the course of the semester, students will design and carry out a small-scale, original investigation on a topic of interest.
Prerequisites: (85241 or 85251) AND (85310 or 85320 or 85340)

85-362 Applied Developmental Psychology
Intermittent: 9 units

"Developmentally appropriate" has become a popular label used to describe activities, materials, and environments designed for children. But what does it mean to be developmentally appropriate, and how is it determined? Are these activities and materials evaluated for their impact on children's development or are they simply designed with a superficial interpretation of theoretical positions or empirical findings? How do we decide what theory to apply when designing or evaluating materials, activities, or contexts for children, and are different theories more informative and applicable than others? The purpose of this class is to think deeply about how our theories and research findings have been and could be applied to support and enhance the development of children in a variety of contexts, such as at home, daycare, school, playgrounds, etc. and to evaluate different activities, materials and/or contexts in reference to various theories and empirical findings. The overall purpose of the course is to understand how theory can inform practice and vice versa.
Prerequisites: 85221

85-370 Perception
Fall: 9 units

Perception, broadly defined, is the construction of a representation of the external world for purposes of thinking and acting. Although we often think of perception as the processing of inputs to the sense organs, the world conveyed by the senses is ambiguous, and cognitive and sensory systems interact to interpret it. In this course, we will examine the sensory-level mechanisms involved in perception by various sensory modalities, including vision, audition, and touch. We will learn how sensory coding interacts with top-down processing based on context and prior knowledge and how perception changes with learning and development. We will look at methods of psychophysics, neuroscience, and cognitive psychology. The goals include not only imparting basic knowledge about perception but also providing new insights into everyday experiences.
Prerequisites: 85102 or 85211 or 85213 or 85219

85-375 Cross Cultural Psychology
Intermittent: 9 units

Human beings share a common genetic inheritance, but our cultural institutions differ in a bewildering variety of ways. This course explores the many different cultural expressions of basic human cognitive and social abilities and needs. We will look at cultural variations in child rearing, mother-child attachment, language socialization, categorization, reasoning, problem-solving, architecture, music, politics, warfare, food-gathering, sex roles, mental disorders, and altered states of consciousness, all with the goal of understanding how the shape of social systems and symbolic expression reflects the economic and adaptive needs of the culture and its people. Among the approaches to these phenomena we will consider are symbolic interaction, cognitive anthropology, dialectic materialism, and modern ethnology.
Prerequisites: 85100 or 85102 or 85198 or 85211 or 85219 or 85221 or 85241 or 85251 or 85261

85-380 In Search of Mind: The History of Psychology
Intermittent: 9 units

This course will focus on three aspects of the origin and growth of experimental psychology. The first is the prehistory of psychology, where the connection of the discipline to the development of modern science, and in particular, its origins in philosophy and physiology, is examined. The second focus of the course is on the different approaches and attempts to define the field that have contested for dominance during much of the life of the discipline. The final major focus of the course is on the modern period (roughly the last forty years) where the influences that brought about the modern counter-revolution in psychology will be examined, and where some conjecture about likely future directions will occur. Two prior courses in psychology.

85-382 Consciousness and Cognition
Intermittent: 9 units

This course will examine the relationship between cognition and consciousness. One particular focus will be on the issue of how complex the processes that are largely unconsciously controlled may be and another is on the interaction of conscious and non-conscious processes in the control of cognition. We will also very briefly examine relevant ideas about consciousness that arise in other fields such as philosophy of mind and physics. The major topics to be included will be drawn from: the experience and functionality of consciousness, neuroscience approaches to consciousness, perceptual and attentional work on consciousness, cognition in altered states of consciousness (in particular, dreaming), implicit memory, and the proceduralization of higher level cognitive processes. The course will consist of our reading and discussing primary research literature from the above areas. There will be a number of short written assignments based on the weekly reading and a term paper.
Prerequisites: 85211 or 85213

85-390 Human Memory
Intermittent: 9 units

Without memory, people would barely be able to function: we could not be able to communicate because we would not be able to remember meanings or words, nor what anyone said to us; we could have no friends because everyone would be a stranger (no memory of meeting anyone); we could have no sense of self because we could not remember anything about ourselves either; we could not predict anything about the future because we would have no recollections of the past; we would not know how to get around, because we would have no knowledge of the environment. This course will discuss issues related to memory at all levels: the sensory registers, i.e., how we perceive things; working or short-term memory; long-term memory or our knowledge base. We will discuss the differences between procedural/skill knowledge, and declarative/fact knowledge. The topics of memory monitoring, feeling and knowing, spread of activation within memory (priming), implicit memory, and amnesia will also be covered.
Prerequisites:

85-392 Human Expertise
Intermittent: 9 units

The process of becoming an expert involves many changes, some quantitative and some qualitative. This course will provide an up-to-date account of the theory and data concerning the development of expertise. Questions addressed include the following. What does it take to become an expert? Are experts born or made? Is the process of acquiring expertise common across different domains from music to sports to science? Research studied in the course will employ a variety of methodologies, from case studies to protocol analysis to computational modeling.
Prerequisites: 85211 or 85213

85-395 Applications of Cognitive Science
Spring: 9 units

The famous psychologist George Miller once said that Psychology should "give itself away." The goal of this course is to look at cases where we have done so -- or at least tried. The course focuses on applications that are sufficiently advanced as to have made an impact outside of the research field per se. That impact can take the form of a product, a change in practice, or a legal statute. The application should have a theoretical base, as contrasted, say, with pure measurement research as in ergonomics. Examples of applications are virtual reality (in vision, hearing, and touch), cognitive tutors based on models of cognitive processing, phonologically based reading programs, latent semantic analysis applications to writing assessment, and measures of consumers' implicit attitudes. The course will use a case-study approach that considers a set of applications in detail, while building a general understanding of what it means to move research into the applied

setting. The questions to be considered include: What makes a body of theoretically based research applicable? What is the pathway from laboratory to practice? What are the barriers - economic, legal, entrenched belief or practice? The format will emphasize analysis and discussion by students.

Prerequisites: 85102 or 85211 or 85213 or 85370

85-406 Autism: Psychological and Neuroscience Perspectives
Intermittent: 9 units

Autism is a disorder that affects many cognitive and social processes, sparing some facets of thought while strongly impacting others. This seminar will examine the scientific research that has illuminated the nature of autism, focusing on its cognitive and biological aspects. For example, language, perception, and theory of mind are affected in autism. The readings will include a few short books and many primary journal articles. The readings will deal primarily with autism in people whose IQ's are in the normal range (high functioning autism). Seminar members will be expected to regularly enter to class discussions and make presentations based on the readings. The seminar will examine various domains of thinking and various biological underpinnings of brain function, to converge on the most recent scientific consensus on the biological and psychological characterization of autism. There will be a special focus on brain imaging studies of autism, including both structural (MRI) imaging of brain morphology and functional (fMRI and PET) imaging of brain activation during the performance of various tasks.

Prerequisites: 85211 or 85213 or 85219 or 85355 or 85429

85-412 Cognitive Modeling
Spring: 9 units

This course will be concerned with modeling of agent behavior in a range of applications from laboratory experiments on human cognition, high-performance simulations such as flight simulators, and video game environments like Unreal Tournament. The first half of the course will teach a high-level modeling language for simulating human perception, cognition, and action. The second half of the course will be a project in which students develop a simulated agent or agents for the application of their choice.

Prerequisites: 15211

85-414 Cognitive Neuropsychology
Spring: 9 units

This course will review what has been learned of the neural bases of cognition through studies of brain-damaged patients as well as newer techniques such as brain stimulation mapping, regional metabolic and blood flow imaging, and attempt to relate these clinical and physiological data to theories of the mind cast in information-processing terms. The course will be organized into units corresponding to the traditionally-defined subfields of cognitive psychology such as perception, memory and language. In each area, we will ask: To what extent do the neurological phenomena make contact with the available cognitive theories? When they do, what are their implications for these theories (i.e., Can we confirm or disconfirm particular cognitive theories using neurological data?)? When they do not, what does this tell us about the parses of the mind imposed by the theories and methodologies of cognitive psychology and neuropsychology?

Prerequisites: 85211 or 85219

85-417 Cognitive Modeling and Intelligent Tutoring Systems
Fall: 9 units

This course addresses the use of cognitive psychology and artificial intelligence to create computer-based "intelligent tutoring systems". Students will learn data-driven and theoretical methods for creating cognitive models of human problem solving. Such models have been used to create educational software that has been demonstrated to dramatically enhance student learning in domains like mathematics and computer programming. In addition to discussion and readings on methods and models of problem solving, learning, and tutor design, the course will have substantial "learning by doing" component. Students will be analyzing data, designing cognitive models and interfaces, and implementing an intelligent tutoring system. Students should either have programming skills (LISP experience is desirable but not necessary) or experience in the cognitive psychology of human problem solving. Additional pre-req preferred: 05-610 Intro to HCI or a course in Artificial Intelligence. This course is also cross-listed with 05-832 in HCI.

Prerequisites: 15211 or 85213

85-419 Introduction to Parallel Distributed Processing
Spring: 9 units

This course will provide an overview of parallel-distributed processing models of aspects of perception, memory, language, knowledge representation, and learning. The course will consist of lectures describing the theory behind the models as well as their

implementation, and students will get hands-on experience running existing simulation models on workstations.

Prerequisites: 85211 or 85213

85-421 Language and Thought
Intermittent: 9 units

This course allows the student to explore ways in which the mind shapes language and language shapes the mind. Why are humans the only species with a full linguistic system? Some of the questions to be explored are: What kinds of mental abilities allow the child to learn language? What are the cognitive abilities needed to support the production and comprehension of sentences in real time? How do these abilities differ between people? Are there universal limits on the ways in which languages differ? Where do these limitations come from cognition in general or the specific language facility? Why is it so hard to learn a second language? Are there important links between language change and cultural change that point to links between language and culture?

Prerequisites: 80150 or 80180 or 85211 or 85213

85-422 Infancy
Intermittent: 9 units

The purpose of this course is to provide students with an extensive background in the field of infant development and to acquaint them with the special methodological and theoretical problems that characterize research in the field. The course will be discussion-oriented and every student will be required to participate actively in both preparing for and contributing to discussion. Specific content areas to be covered include perception, memory, conceptual development, attachment, emotions, social development, and the origins of language. We will cover general readings as well as conflicting empirical studies and theoretical accounts that we will attempt to disentangle and resolve in class discussion.

Prerequisites: 85221

85-423 Cognitive Development
Spring: 9 units

The general goals of this course are that students become familiar with the basic phenomena and the leading theories of cognitive development, and that they learn to critically evaluate research in the area. Piagetian and information processing approaches will be discussed and contrasted. The focus will be upon the development of children's information processing capacity and the effect that differences in capacities have upon the child's ability to interact with the environment in problem solving and learning situations.

Prerequisites: 85221

85-429 Cognitive Brain Imaging
Intermittent: 9 units

This seminar will examine how the brain executes higher level cognitive processes, such as problem-solving, language comprehension, and visual thinking. The topic will be addressed by examining what recent brain imaging studies can tell us about these various kinds of thinking. This new scientific approach has the potential of providing important information about how the brain thinks, indicating not only what parts perform what function, but also how the activity of different parts of the brain are organized to perform some thinking task, and how various neurological diseases (e.g. aphasia, Alzheimer's) affect brain activity. A variety of different types of thinking will be examined, including short-term working memory storage and computation, problem solving, language comprehension, visual thinking. Several different technologies for measuring brain activity (e.g. PET and functional MRI and also some PET imaging) will be considered, attempting to relate brain physiology to cognitive functioning. The course will examine brain imaging in normal subjects and in people with various kinds of brain damage.

Prerequisites: 85211 or 85213 or 85412 or 85414 or 85419

85-442 Health Psychology
Intermittent: 9 units

This course is concerned with how behavior and psychological states influence the development of and recovery from disease. The class provides an overview of existing psychological and epidemiological data on the relationship between behavior and disease and addresses the issue of how behavior, emotion and cognition can influence the disease processes. Topics include: measures and concepts, stress and disease, stress and coping, personal control, helplessness and disease, social support and health, reactivity to stress, behavior and hypertension, coronary heart disease, infectious diseases and immune function, and the effectiveness of behavioral interventions in health. Special permission of instructor required.

85-443 Social Factors and Well-Being

Intermittent: 9 units

This course will focus on the role that our social environment plays in our feelings of well-being and in the maintenance of our mental and physical health. Topics to be discussed include marriage, widowhood, loneliness, social support, social participation, social aspects of personality (e.g., social anxiety, extraversion, agreeableness, and hostility), social stressors (betrayal and conflict), discrimination, and socioeconomic status. We will consider how each social factor develops, the extent to which we can alter it or its effects on our lives, and how it influences our overall well-being. Instructor permission is required.

85-444 Relationships

Fall: 9 units

The primary goal of this course is to introduce you to social psychological theory and research on the topic of relationships. Although a variety of relationship phenomena will be discussed, a heavy emphasis will be placed on research that addresses fundamental processes in close relationships. The coverage of material will include a review of historical roots and classic approaches to the scientific study of relationships, as well as exciting new research and theory on particular subtopics. The majority of class time is spent discussing and evaluating recent research. Special emphasis also is given to learning and critically evaluating the methodological tools that are used to study close relationships. The goal is for students to leave this course with a broad overview of the field and an in-depth understanding of particular subtopics. This is an advanced seminar in which students will be expected to read original research articles and chapters on assigned topics and come to class prepared to discuss the material. Readings will consist of theoretical and empirical articles from psychology journals and related sources. Additional course requirements will involve short, weekly writing assignments, student presentations of research articles, and a written research proposal. Over the course of the semester, students will design and carry out a small-scale, original investigation on a relationships topic of interest.

Prerequisites: (85241 and 85340) or (85251 and 85340)

85-446 Psychology of Gender

Spring: 9 units

This course is devoted to the investigation of psychological gender rather than biological sex. That is, sex differences will be explored from a social psychological (e.g., socialization) perspective. Implications of both male gender role and female gender role in the areas of relationships and health will be the course focus.

Prerequisites: 85241 or 85251

85-480 Internship in Clinical Psychology

All Semesters: 6-12 units

Internship in Clinical Psychology introduces students to clinical psychology and related fields through course-work and practicum experiences. Students have the opportunity to work in applied research and/or clinical settings, in conjunction with learning about clinical psychology practice. Examples of available internship placements are: Western Psychiatric Institute and Clinic, Contact Pittsburgh, The Parental Stress Center, and The Children's Institute. Please contact Dr. Beth Zimick if you are interested in enrolling at bethc@andrew.cmu.edu.

Prerequisites: 85251 or 85261

85-482 Internship in Psychology

Fall and Spring: 3-12 units

The Internship in Psychology is designed to enable students to gain experience in professional settings related to their studies in Psychology and earn credit for the intellectual work involved. It is the students responsibility to locate an internship site and on-site supervisor, as well as to identify a CMU faculty sponsor. The student registers for the internship by submitting a completed internship form to Theresa Kurutz in Baker Hall 343.

85-484 Practicum in Child Development

Fall and Spring: 9 units

This guided field experience is designed to help students deepen their understanding of developmental psychology by assisting in a preschool or kindergarten classroom and discussing the ways that their experiences relate to the theories they have learned previously and to new readings. Each student will individually schedule a consistent 6 hours per week helping in a Children's School classroom (preferably 2 or 3 chunks of time). Classroom duties will include working one-on-one and with small groups of students as they do puzzles, art projects, dramatic play, etc., as well as helping with snack, playground supervision, classroom cleanup, and storytime. Each student will be expected to keep a journal 1) relating general experiences to developmental theories and 2) documenting the

development of a particular child during the semester. All students will meet for a 1 hour weekly discussion with the director. Discussion topics and related readings will be selected collaboratively, based on issues/questions raised by the group's observations and discussions. Prerequisites: 85221

85-501 Stress, Coping and Well-Being

Intermittent: 9 units

This course will examine the relationship of stress and coping to psychological and physical well-being. Discussions will be centered on readings from current theoretical and empirical articles. Anticipated discussions include the definitions of stress and coping from multiple theoretical perspectives, issues relevant to the measurement of stress and coping, the psychological and physical consequences of stress, the time course of assessing well-being, and "adaptive" vs. "maladaptive" coping responses. This class is a small, upper level seminar that will consist of minimal lecture and a majority of class discussion. Active class participation is required. Prerequisites: (85241 and 85340) or (85251 and 85340)

85-505 Readings In Psychology

All Semesters: 3-12 units

As the name implies, the emphasis in the Reading course is on reading articles and books in some specified area. The students work in the course must lead to the production of a written paper which will be read by the instructor directing the readings. Often the reading is related to a research project which the student may wish to conduct. Readings courses have also been used to give students an opportunity to receive instruction in areas which are not included elsewhere in our course listing. The course may be taken for any number of units up to 9, depending upon the amount of work to be done.

85-507 Research in Psychology

Fall: 3-12 units

This course may include field study, applied work, or laboratory research. The student should have previous training in the basic research skills that will be used in his/her project, especially statistical methods and experimental design. Independent Research Projects will be supervised by a faculty member and must result in a written paper. It is the students responsibility to make arrangements for independent study courses with individual faculty members. This should be done the semester before a student wishes to register for one of these courses. The course may be taken for any number of units up to 12, depending upon the amount of work to be done.

85-508 Research in Psychology

Spring: 1-18 units

This course may include field study, applied work, or laboratory research. The student should have previous training in the basic research skills that will be used in his/her project, especially statistical methods and experimental design. Independent Research Projects will be supervised by a faculty member and must result in a written paper. It is the students responsibility to make arrangements for independent study courses with individual faculty members. This should be done the semester before a student wishes to register for one of these courses. The course may be taken for any number of units up to 12, depending upon the amount of work to be done.

85-601 Senior Thesis

Fall: 9 units

This course is intended for senior Psychology or Cognitive Science majors who wish to conduct a research project under the direction of a faculty advisor. The project topic is to be selected jointly by the student and the advisor. The project will culminate in a senior paper which will be presented to the Department Head at the end of Fall Semester. Prerequisite: Grade of B or better in a previous research course required to enter, grade of B or better in first semester of senior thesis course required to complete, and permission of instructor. A formal proposal is required in the first semester. This course differs from the Honors Thesis sequence (66-501,502) in that it does not require Honors standing in HSS (i.e., there are no QPA requirements). This course differs from Research in Psychology (85-507,508) in that the student's original contribution to the research is expected to be more substantial, and in that a final written report of the project is to be presented to the Department.

85-602 Senior Thesis

Spring: 9 units

This course is intended for senior Psychology or Cognitive Science majors who wish to conduct a research project under the direction of a faculty advisor. The project topic is to be selected jointly by the student and the advisor. The project will culminate in a senior paper which will be presented to the Department Head at the end of Fall Semester. Prerequisite: Grade of B or better in a previous research

course required to enter, grade of B or better in first semester of senior thesis course required to complete, and permission of instructor. A formal proposal is required in the first semester. This course differs from the Honors Thesis sequence (66-501,602) in that it does not require Honors standing in HSS (i.e., there are no QPA requirements). This course differs from Research in Psychology (85-507,508) in that the student's original contribution to the research is expected to be more substantial, and in that a final written report of the project is to be presented to the Department.

Social & Decision Sciences

88-104 Decision Processes in American Political Institutions
Fall: 9 units

This is an interdisciplinary introduction to the study of politics and government, drawing mostly on political science, but also on economics. It familiarizes the student with the basic structures and processes of American government. The main theoretical tools are spatial models of political decision making, and models of collective action problems. The course focuses on politics and government in the United States, but explicit comparisons are made with politics in other countries. Grading is usually based on two midterm exams and a final exam, as well as a short writing assignment, several quizzes and homework.

88-110 Experiments with Economic Principles
Fall: 9 units

This course is designed to teach the basic principles of economics through the use of experiments. In each experiment you will be an active participant attempting to make deals with other traders in the market. At the end of the experiment it is time to really put economics to the test---can economic theory really explain the complex interactions of the participants in your experiment? One nice feature of these experiments is that you can be both a participant and an observer, and you often will learn nearly as much about economic principles from your experience as a participant as you will from the analysis of the experiment as an observer. Topics covered include basic market behavior, auctions, rent control, pollution, network externalities, information economics, and international trade.

88-111 SDS Freshman Seminar: Human Rights and Global Politics
Fall: 9 units

The purpose of the seminar is to study human rights from different dimensions. First, we will examine the meaning of the term and the issues associated with defining the human rights field. What are these rights? What is their origin? Secondly, we will examine which rights/issues have been raised in the contemporary international political system and the responses from major international actors such as the United States, the Western European countries, International Organizations, and the NGO's such as Amnesty International. The central issue here is one of answers and policies toward human rights abuses/issues. Finally, we will analyze a number of case studies. Some case studies will be presented in the lectures, some will be discussed by the students. Students will be asked to do research and report on a case of human rights abuses looking not only at the issue or conflict that has led to those abuses, but also international responses to the issue.

88-114 SDS Freshman Seminar: Everyday Irrationality
Intermittent: 9 units

This seminar will cover the historical progression from belief in hot irrationality--i.e., emotional interference with an otherwise pristine intellect (Plato, Freud) through cold irrationality--i.e., clear thought stymied by common cognitive biases and heuristics (Tversky and Kahneman)--through a possible integration of hot and cold approaches--e.g. resulting from attentional mechanisms (Simon, Loewenstein, Lerner). Then the professor and students will discuss belief in ESP, alternative medicines, faith healing and Nazism in terms of the principles proposed. During the last half of the semester, students will choose a particular irrational belief to study and will both present to other students and write a term paper describing its acceptance (by at least some people) and possible reasons for such acceptance. The major text will be Dawes's new book "Everyday Irrationality: How Pseudo-Scientists, Lunatics, and the Rest of Us Systematically Fail to Think Rationally." This book will be supplemented by selected readings from Plato, Freud, Hines's book on "Pseudoscience and the Paranormal," Gilovich's book of "How We Know What Isn't So," a book of first-hand accounts by the perpetrators of the Holocaust entitled "Death Dealers," and finally Browning's book of "Ordinary Men."

88-115 Risk Communications for Health Decisions
Intermittent: 9 units

This seminar will explore how people make decisions about risk behaviors in various contexts relating to their health, including diet and exercise, sexual behavior, smoking, drinking, drug use, etc. The main focus of the course will be looking at efforts to improve health by educating people to make better decisions about reducing their own health risks. Students will participate in active class discussion, debating the benefits of different approaches to public health. The mid-term project will include basic research and data collection on a health behavior. The final project will include the production and planned evaluation of a public service announcement, aimed at improving health decisions and behaviors. Readings will include book chapters and original research articles relating to the psychology behind such behaviors and trade-offs.

88-116 HSS Freshman Seminar: Psychobabble
Intermittent: 9 units

At the beginning of the semester we will go through my annotated dictionary of psychobabble and show videos of psychobabble in "living action"--e.g. recovering repressed memories of being raised in a satanic cult, believing it is possible to communicate with autistic children through "facilitated communication" where they indicate to a skilled typist/therapist what they want to spell out on a keyboard (without looking). Then I will have students volunteer to lead discussions about particular types of psychobabble. Attendance will be required. Evaluation will be on the basis of presentations and a term paper.

88-117 Social Dilemmas from Overpopulation to Global Warming
Spring: 9 units

Social dilemmas are situations in which a number of people make simultaneous choices between what is roughly termed "cooperative" versus "non-cooperative" behavior where the individual payoffs for the non-cooperative choice are always higher than for the non-cooperative choice - no matter what other people involved in the decision do. Yet universal cooperation is preferred to universal non-cooperation by all the people making choices. The first part of the seminar will be devoted to reading the classic theoretical arguments about social dilemmas, and to the surveying some of the empirical findings of social psychologists such as Dawes about what variables other than payoff changes might enhance the probability of cooperative choices, e.g., "identification with the group". After becoming familiar with the theoretical and empirical literature, the members of the seminar will be asked to give presentations concerning either their own ideas or the ideas of some other theorist or investigator about how to enhance the incidence of cooperative choice. Each member of the seminar will be expected to lead one session presenting such ideas and to write a term paper about them.

88-120 Reason, Passion and Cognition
Spring: 9 units

This course will introduce students to major concepts and theories in the social and decision sciences. In particular, we will focus on how cognition and emotion shape judgment and choice. Class meetings will include a mixture of lecture and discussion. We will address such questions as: In what ways do specific emotions influence judgments and choices? What are some common mistakes in judgment and decision making? How do attitudes form and change? Can information shape our choices even if we do not consciously recognize the information? Throughout the course, the emphasis will be on understanding: (1) basic theories and research findings of decision science and psychology, and (2) the relevance of research findings to everyday life.

88-181 Topics in Law: 1st Amendment
Fall: 9 units

In their firm desire to perfect the new Constitution, which defined and limited the powers and roles of their new government, the founding fathers insisted on explicit statements that would protect the rights of the new nation's citizens. Indeed, the protection of these essential rights in many ways drove and defined their successful rebellion from Britain. This impulse resulted in ten amendments to the Constitution, which we have come to know as the Bill of Rights. The very first (and arguably considered at the time as the most essential) of these was the First Amendment, which we sometimes call the "free speech" amendment to the Constitution. This amendment guarantees every U.S. citizen five freedoms: freedom of religion, speech, press, peaceable assembly, and the freedom to petition the government for redress of grievances. This course examines the historical and philosophical roots of this key constitutional amendment, how it has been fleshed out and defined over time through case law, and the bases of some more recent critics of this amendments and current interpretations.

88-184 Topics of Law: The Bill of Rights

Spring: 9 units

This course examines the history and place of the Bill of Rights in our nation's constitutional framework. It focuses on the historical origins of the U.S. Constitution, of each of the first ten amendments to the Constitution (that we refer to as the "Bill of Rights"), how the meanings and interpretations of these have evolved over time, and what they mean to us today. Each article of the Bill of Rights will be examined in terms of its original intentions, and then through cases that have challenged and been interpreted through the Bill's articles.

88-198 Research Training: Social and Decision Sciences

Fall and Spring: 6,9 units

This course is part of a set of 100-level courses offered by H&SS departments as independent studies for second-semester freshmen, and first- or second-semester sophomores, in the College. In general, these courses are designed to give students some real research experience through work on a faculty project or lab in ways that might stimulate and nurture subsequent interest in research participation. Faculty and students devise a personal and regularized meeting and task schedule. Each Research Training course is worth 9 units, which generally means a minimum for students of about 9 work-hours per week. These courses are offered only as electives; i.e., they cannot be applied toward a college or major requirement, although the units do count toward graduation as elective units. Additional details (including a roster and descriptions of Research Training Courses available in any given semester) are available in the H&SS Academic Advisory Center. Prerequisites/restrictions: for H&SS students only; only for second-semester freshmen, or first- or second-semester sophomores; minimum cumulative QPA of 3.0 (at the time of registration) required for approved entry; additional prerequisites (e.g., language proficiency) may arise out of the particular demands of the research project in question.

88-202 History of Public Policy in the United States

Fall: 9 units

This course will describe and analyze aspects of the development of public policy in the United States from the colonial era to the present. For the purposes of this course, public policy will be defined as the making of rules and laws and their implementation by government either: 1) in response to the failure of private markets to reach desirable outcomes; or 2) in an attempt to achieve a particular normative vision of what the world/society ought to be like. This course assumes that the public policy landscape is complex but still comprehensible given the proper set of analytical frameworks and appropriate historical background. Particular emphasis will be placed on: changing views about the authority of the government to intervene in economic and social issues; the best way to balance individual and collective interests; and the variability within society of the life courses of individuals. Topics to be covered include: property rights, science and technology policy, environmental regulation, competition, civil rights, and drug policy.

88-205 Comparative Politics

Spring: 9 units

The aim of the course is to discuss, analyze and compare democratic, totalitarian and authoritarian regimes. Each of the models will be analyzed both from a theoretical and a practical perspective emphasizing the rights and obligations of the individual, the form in which the government functions and the process through which countries arrive at a particular form of government. The course will focus on British democracy, Nazi Germany, and Chile's authoritarianism. The course will conclude with an analysis of current processes of democratization and transition to capitalism. No prerequisites.

88-220 Policy Analysis I

Fall: 9 units

This course provides an introduction to theories and methods for policy analysis. The main focus of the course is to develop an understanding of how theories from social science, such as economics, can help us understand policy issues such as allocation, regulation, and welfare. Throughout the course we analyze outcomes produced by private markets, by examining consumer choice, the supply and demand of factors and produced goods, and general and partial equilibrium. We also analyze the efficiency and welfare properties of such outcomes, paying special attention to the role of policy in influencing market outcomes. We consider how policy can address the efficiency and welfare shortcomings of markets that may result from informational asymmetries, industrial organization, moral hazard, transactions costs, and bounded rationality. Markets are compared in this light with organizational, governmental, and other modes of resource allocation. Grading will be based mainly on 3 exams. Homework assignments and/or

quizzes will comprise a smaller part of the grade. Priority access is given to SDS junior and senior students.

88-221 Policy Analysis II

Spring: 9 units

This course is an extension of Policy Analysis I and focuses on a normative analysis of government action. The course begins by considering justifications for government action drawing on work in political philosophy. It then compares different institutional approaches governments may adopt in attempting to correct market failures and in pursuing objectives other than efficiency. The basic concepts and tools of cost benefit analysis are then presented. Students are involved in individual and group projects applying the class material to specific policy issues. Prerequisites: 73250 or 73251 or 88220

88-222 Policy Analysis III

Fall and Spring: 12 units

Students in this course apply the research and analytical methods learned in their other courses to a real-world problem. Students decide how to structure the problem, divide into teams responsible for its different parts, identify and analyze relevant literature, collect data, synthesize their results, and present their conclusions in oral and written form to a review panel of individuals concerned with the problem. Faculty members help them along the way. Performance is based on students' contribution to the process and substance of the class, as observed by the faculty and by their fellow students. One or two such projects is offered every term. A complete list of previous topics is available from the department.

88-223 Decision Analysis and Decision Support Systems

Spring: 9 units

This course emphasizes explicit procedures for analyzing complex decisions. The topics covered include: decision trees and other models of decisions involving uncertainty; methods for quantifying preferences and expert opinion; risk analysis; and the development and use of computerized decision aids ranging from spread sheet programs to highly specialized decision support models. Prerequisites: 36201 or 36211 or 36217 or 36220 or 36225 or 36247 or 70207 or 36207

88-251 Empirical Research Methods

Spring: 9 units

This course teaches students how to evaluate and conduct original research regarding human behavior, whether it be in economic, social, or political settings. The course gives students practical experience in many of the most commonly used research techniques, including surveys, experiments, and quasi-experimental analysis. Although the course focuses primarily on the relationship between formulating research questions and implementing the appropriate methods to answer them, students can expect regularly to apply the statistical techniques learned in the course prerequisites, including regression. Prerequisites: 36201 or 36207

88-260 Organizations

Fall: 9 units

Even in a "market" economy, the preponderance of economic activity is carried out through firms and other organizations. The course begins by examining economic theories of the firm, and explores some of the canonical questions, such as why are their firms, how the separation of ownership and control of a firm shapes decision making, what determines the boundary between organizations and markets (e.g., make-or-buy decisions), what types of firms are most innovative, and how new technologies affect organizational structure. A second set of issues concerns how various organizational forms motivate, or fail to motivate, employees. The central concepts will be fleshed out by examining business firms, as well as not-for-profit enterprises, political parties, and government agencies.

88-302 Behavioral Decision Making

Fall: 9 units

Behavioral decision making is the study of how people make decisions, in terms that can eventually help them to make better decisions. It draws together research from psychology, economics, political science, and management, among other fields. It has applications that range from managing potentially hazardous technologies, to involving patients more fully in the choice of medical procedures, to the design of computer-interactive systems. The course covers behavioral theories of probabilistic inference, intuitive prediction, preference, and decision making. Topics include heuristics and biases in inference and prediction, risk perceptions and attitudes, strategies for combining information from different sources and dealing with conflicting objectives, and the roles of

group and emotional processes in decision making. The course emphasizes the mutually reinforcing relationship between theory and application.

Prerequisites: 36201 or 36207 or 36211 or 36217 or 36220 or 36225 or 36247 or 70207

88-307 Principles of Individual and Collective Irrationality

Spring: 9 units

The course begins with a survey of selected topics in Pseudoscience and the Paranormal (the title of the first textbook, by Terrance Hines). We then discuss cognitive principles that help explain:

How We Know What Isn't So (the title of the second textbook, by Thomas Gilovich) and read a number of papers and a book chapter about the role of social support and consensus in forming and maintaining belief. The course then focuses on two specific belief systems: Nazism, and belief in cannibalism and child sexual abuse by organized satanists in this country in recent years. The Nazism section is based on accounts by some Nazis themselves: Rudolf Hoess, the major Commandant at Auschwitz (his autobiography), and Ordinary Men (title of Christopher Browning's book) about Order Police Battalion 101, middle-aged men who volunteered for police work to help the war effort and ended up implementing the final solution in Poland. The satanic cult beliefs are covered in a number of journal articles, magazine write-ups, and a Frontline PBS presentation. Each class period will be led by a student or by a pair of students and by Dawes. Finally, each student will pick an irrational belief system other than Nazism or satanic cult belief to study and analyze. Reviews of this belief system will be due approximately 60% of the way through the semester, and a final paper analyzing its cognitive and social supports will be due at the end. That final paper, with a short class presentation, will be required in lieu of a final examination. Depending on the number of students in the course, these final projects may or may not be discussed with the other students in class. In contrast to the reviews and papers, three hour-long quizzes will concentrate mainly on factual matters, so that we can be assured that all materials covered are known by all.

88-314 Politics through Film

Summer: 9 units

In this course we will use films, readings and discussions to enhance our ability to analyze, understand, and explain politics. The course is about political power, authority, leadership, ideologies, war, nationalism and resistance to authority. We will use major commercial films to explore some fundamental political problems regarding governments and societies. The central themes to be discussed in both the readings and the films will be tyranny and its impact on the people, resistance to tyranny and authority, and nationalism and war. The question of tyranny will be analyzed in the context of a variety of historical experiences, including Nazi Germany, Stalin's regime, Latin American experiences, and racial problems in the U.S. To analyze the problem of nationalism and war, we will use material dealing with World Wars I and II and Vietnam.

88-316 Game Theory

Intermittent: 9 units

Game theory is the branch of decision theory in which decision problems interact. Due to its flexibility and strategic nature, game theory is used heavily in other academic areas such as economics, political science, biology, and even competitive sports. This course will cover those parts of game theory of special interest to social scientists. We will discuss specific elements of the formal theory of games as well as experimental results. Throughout the course we will examine applications of game theory to problems across the social sciences.

88-326 Theories of International Relations

Fall: 9 units

This course has three major dimensions. Assumptions and propositions of the leading theories of international relations will be reviewed. This course also seeks to ensure that students clearly understand how newer theoretical approaches to the study of international relations build upon or depart from classical theories. Finally, theories will be tested against the historical record by examining major policy decisions and events such as the Cuban missile crisis, the Vietnam War, the Soviet invasion of Afghanistan, the Persian Gulf War, and the current war against global terror.

88-329 American Foreign Policy: 1945-Present

Fall and Spring: 9 units

This course provides an introduction to the study of U.S. foreign policy. Its main focus will be on problems and possibilities confronting the world during the Cold War as well as global political changes in the post-Cold War era and since 9/11. Important foreign policy strategies which will be discussed include the strategy of

containment, NSC-68, the Eisenhower-Dulles "New Look," the Kennedy-Johnson "flexible response," "détente," the democratic peace, and contemporary approaches to combating global terror. Theoretical readings in history and political science will be used as analytic filters to assess both scholarly evaluations of American foreign policy and key historical episodes.

88-341 Organizational Communication

Fall: 9 units

Much of the work in groups and organizations consists of communication. You communicate to get information that will be the basis of decisions, to provide a vision for the people who work for and with you, to coordinate activity, and to sell yourself and your work. The goal of this course is to identify sources of communication problems within an organization and ways to overcome them. To do this requires that we know how communication normally works, what parts are difficult, and how to fix it when it goes wrong. The focus of this course is on providing you with a broad understanding of the way communication operates within dyads, work groups, and organizations. This course is not a practicum in public speaking or writing, although you will get some experience writing, speaking, and managing impressions. Rather the intent is to give you theoretical and empirical underpinnings for the communication you will undoubtedly do when you return to work. Readings come from both the research and the managerial literatures. Among the topics considered are managerial communication, persuasion and conformity, self presentation and person perception, social networks. Cases and group projects give you an opportunity to apply what you've learned.

Prerequisites: 36201 or 36207 or 36217 or 36220 or 36225 or 36247 or 70207

88-343 Economics of Technological Change

Intermittent: 9 units

This course will consider the determination of innovative activity and performance, and the effect of innovation on productivity, economic growth, and social welfare. We will focus particularly on the characteristics of markets and firms that influence industrial innovation. Such characteristics include, for example, market concentration, firm size, the strength of patent protection, and the vitality of the basic science and technology underlying innovation in a given industry. We will also study the economics of the adoption and diffusion of innovation. In addition to drawing on economic theory, the course will emphasize empirical studies of innovation and technological change, and will selectively exploit case study and institutional studies.

Prerequisites: 73250 or 73251 or 88220

88-345 Perspectives on Industrial Research and Development

Intermittent: 9 units

Incandescent and fluorescent electric lights; nylon and Kevlar; the atomic bomb; the transistor and integrated circuits; Post-it notes; Teflon; Silly Putty; GameBoys; and biopharmaceuticals (from Viagra and Levitra to Paxil and Enbrel), among a panoply of other consumer and industrial goods, are all products that emerged from organized industrial research and development (R&D) programs. The beginnings of this new institution in the late 19th century, its rapid rise in the first third of the 20th century, its flourishing in the middle third of the 20th century, and its decline and reorganization in the last decades of the 20th century and first decade of the 21st century are the principal focus of this advanced reading seminar. What factors led to the establishment of modern R&D? Why did industrial R&D laboratories appear in the US and other industrialized nations? How did their creation change the character of science, technology, and business? How did the institutionalization of R&D affect the work of individual inventors, engineers, and scientists? Does big business now dominate R&D in the United States, or does "the little guy" (including university-based "start ups") still play an important role in technological innovation? What about the interaction of universities and industrial R&D programs? How has industrial R&D been "managed"? How has federal science and technology policy affected industrial R&D? With the globalization of business, is industrial R&D also becoming global, and if so, how does industrial R&D work on a global scale? Why did the last decade of the 20th century see the decline or disappearance of numerous prestigious industrial research organizations? What is the future of industrial R&D in the 21st century? These are some of the questions explored in this course, which is open to serious students from all colleges.

88-346 Environmental History and Politics Since Silent Spring

Spring: 9 units

This course explores the development of the modern environmental movement and its impact on American politics since the publication of Rachel Carson's landmark study, *Silent Spring*, in 1962. It also

examines the role of the state in creating and enforcing meaningful environmental regulations at a time when people were transitioning from a conservation approach to natural resources to a health or environment-based approach. Topics that will receive particular attention include toxic waste cleanup, river and drinking water regulations, water conservation in the west, agriculture, and the distinct interrelationships between urban and rural environments and their constituencies.

88-347 Complex Technological Systems: Past, Present, and Future
Intermittent: 9 units

The Internet is only the latest example of a complex technological system that fundamentally alters the way that we act in and think about our world—and about technology itself. During the last two centuries such complex technological systems have emerged, ranging from transportation systems such as the railroad and mass-produced automobiles running on paved roads and superhighways to networked information systems including the telegraph, the telephone, and radio and television. What are the common features of these complex technological systems? When do they emerge? How are national and international standards for these systems established? How far reaching are the consequences of these systems in society, business, and in other complex technological systems? Can they be predicted? Can they be controlled? Can such complex technological systems be fully comprehended and modeled? In a world in which many of these systems are interconnected, how vulnerable are current societies (such as those in the West) that depend on them, especially in an age of global terrorism? These are but some of the questions this lecture and discussion course will tackle using cases from the past, the present, and the future. Students are graded through weekly quizzes, midterm and final examinations, and class participation. Prerequisites: junior or senior standing.

88-357 Comparative Foreign Policy: China, Russia, and the US
Intermittent: 9 units

The purpose of this course is to compare and analyze the Foreign Policies of China, the United States and the former Soviet Union. The first section of the course will be geared to analyzing the foreign policies of the three major powers since World War II until today. The second section will be devoted to analyzing major foreign policy problems and the position that China, the US, and the former Soviet Union had, or have, in relation to those problems. Among the issues discussed will be the Arms Race, Nuclear Proliferation, the conflicts in the Middle East, the end of communism, and the war in Afghanistan.

88-358 Policy Making Institutions
Fall: 9 units

Institutions are the “rules of the game” that provide the incentives and constraints for individuals and group behavior. In the U.S., policy institutions range from Constitutional provisions (e.g., separation of powers, federalism) to specific legislation and regulations to informal norms and customs of political parties and interest groups. In this course, rational choice theory and simple spatial modeling are used to explore how preferences and institutions shape policy outcomes, along with the factors that lead to institutional changes. Topics include the role of supermajoritarian institutions and legislative “gridlock,” the privatization of government services, and the causes and consequences of electing versus appointing judges. Prerequisites:

88-359 Globalization
Spring: 9 units

Globalization entails an erosion of the national borders and the expansion of trade and technology. In this course we will analyze the political and economic implications of the process of globalization and its impact on Developed and Less Developed Countries. Among the issues discussed will be the increased power of Transnational Corporations and Nongovernmental organizations as well as the power of International Organizations such as the World Bank and the IMF. The course will also focus on the impact of globalization on poverty and wealth across the world.

88-360 Behavioral Economics
Intermittent: 9 units

This course introduces students to behavioral economics, an emerging subfield of economics that incorporates insights from psychology and other social sciences into economics. We will examine evidence on how human behavior systematically departs from the standard assumptions of economics, and then investigate attempts by behavioral economists to improve economic analyses. Prerequisites: (21111 or 21120) and (88220 or 73251)

88-370 African Politics

Intermittent: 9 units
The course will introduce students to the political history of pre-colonial administration, conflict resolution and relations between political entities in Africa. The impact of slavery and colonialism on the continent will be discussed. Relations between colonial state and the indigenous political forces will be discussed with special emphasis on selected African territories. Nationalism and resistance to foreign rule and post-colonial state will be discussed. Topics such as economic development and foreign aid will be covered with special emphasis on structural adjustment programs. Specific case studies on civil wars, conflict resolution, and civil societies will be discussed. Issues of Pan-Africanism, African unity, and impact of globalization on African politics will also be covered.

88-371 Entrepreneurship, Technological Change, and Regulation in Theory and Practice

Intermittent: 9 units
This course focuses on the interrelationships between public policy and technological change, with special emphasis on the role of entrepreneurship. Students develop a fundamental understanding of regulatory institutions, the evolution of the US regulatory state, and innovation and diffusion of new technologies in the context of the state, technological change, and competition policy. These concepts will be fleshed out using historical and contemporary case studies, including the information and communications industry, transportation industry, and energy industry, among others. Prerequisites: 73251 or 79202 or 88202 or 88220

88-377 Attitudes and Persuasion
Spring: 9 units

This advanced undergraduate course will focus on the topic of attitude change and how various persuasive techniques are used to shape human response. The dynamics of propaganda and what makes the techniques effective on social and consumer decisions will be addressed. The primary goals of the course are to 1) understand the dynamics of attitude change; 2) explore the mechanism by which attitude change techniques operate and 3) examine relevant theories and research in persuasion. Examples of topics covered include the origins of attitudes, how attitudes influence judgments, social power and attitude change, and how individual decisions are influenced by the mass media. Classic and contemporary research in the area of persuasion will be examined in the form of course readings and assignments. Prerequisites: 85241

88-378 International Economics
Intermittent: 9 units

This course analyses the causes and effects of commercial and financial transactions between nations and the major policy issues raised by these transactions. The first half focuses on international trade and commercial policy using the tools of microeconomic analysis. The second half deals with balance of payments and exchange rate issues with emphasis on problems of macroeconomic policy in open economies.

88-384 Conflict and Conflict Resolution in International Relations
Intermittent: 9 units

Course will introduce students to concepts of conflict, conflict resolution, and peace in international relations. Causes of war, alliances, and role of non-state actors in conflict will be examined. There will be also discussion on foreign policy decision making, mediation, negotiation and international law. The following specific cases will be discussed – the Middle East Peace Process (Security Council Resolution 242, Camp David, Oslo Agreement and Geneva Accord); Indo-Pakistan dispute (Lahore Declaration 1999); War in Bosnia and Herzegovina and the Dayton Peace Accords; El Salvador Peace Agreement (between the Government of El Salvador and the Frente Farabundo Marti para la Liberacion Nacional); and the Algiers Agreement between Eritrea and Ethiopia. Globalization, terrorism, and conflict resolution will also be covered.

88-385 Managerial Decision Making
Fall: 9 units

People in organizations make decisions, with important consequences, every day. Therefore, an understanding of decision-making is important in any education in management or economics. However, while a large number of courses in these curricula expose students to how decisions should be made, very few focus on how people actually make choices. This course addresses this topic by focusing on how decisions made by real people – and in particular decisions in business contexts – differ from the theoretical predictions of rational decision-making. We specifically focus on common areas of biased decision-making, their basis, and how they

might be corrected. The focus of the course is on both individual and competitive decision-making.

Prerequisites: 73250 or 73251 or 88220

88-386 Desires and Decisions

Spring: 9 units

This course explores how the desirability of experiences and (consumer and public) goods are determined. Through the lens of psychological research we will explore (1) the construction of preferences, (2) how preferences are affected by factors such as context, adaptation, memory, culture, and emotion, and (3) attempt to understand how the malleability of our preferences affects our personal decisions, economic markets, the law, and public policy. Class meetings will include a mixture of lecture and discussion, with a stronger emphasis on discussion. Throughout the course, the emphasis will be on learning to critically evaluate advanced theories and research findings of decision science and psychology, and carefully articulate those critiques orally and in writing.

Prerequisites: 88120

88-387 Social Norms and Economics

Intermittent: 9 units

Social norms play an important role in individual economic decisions and influence economic exchange outcomes. This raises several important questions. What mechanisms are effective in enforcing social norms? To what extent and in what contexts might we expect norm obedience absent external economic incentives? How should we take into account the role of social norms when designing economic institutions? This course discusses experimental research in economics, law and psychology that takes steps towards answering these and other related questions.

88-391 Technology and Economic Growth

Fall: 9 units

The importance of economic growth is difficult to overstate. The more than tenfold increase in income in the United States over the last century is the result of economic growth. So is the fact that incomes in the United States and Western Europe are at least thirty times greater than incomes in much of Sub-Saharan Africa. Economic research has clearly identified technological innovation as the engine of long-run economic growth. This course seeks to provide students with analytical frameworks that will enable them to understand the economic growth process, the role that technological innovation plays in that process, and the policies and institutions that can enhance and sustain technological innovation in industrialized societies.

88-398 Independent Study

All Semesters: 1-18 units

Students conduct research or other independent academic study under the supervision of a Social & Decision Sciences faculty member. Students who wish to engage in research should seek out a faculty member whose interests are appropriate to the topic.

Prerequisite: Permission of a faculty sponsor.

88-407 Health Risk Communication

9 units

This course will cover the relationship between risk perception and health behavior, focusing on how to effect behavior change through communication. The course will begin by exploring how people make decisions about their health, with an emphasis on how we as researchers can learn what factors affect such decisions. We will then turn to the question of how to change unhealthy behaviors by helping to improve this decision making. Finally, the course will cover strategies for evaluating these techniques, to determine whether they have been effective. Throughout the semester, students will conduct a multi-stage research project, beginning by assessing people's decisions on a health topic of their choice and ending with the creation and production of a health communication intervention and a plan for its evaluation. Readings will consist primarily of original journal articles describing research and reviews, which students will be expected to read prior to class for discussion. Grading will be based on mid-term and final papers describing the research project and on short assignments throughout the semester relating to class readings. This course is aimed at students with a background in Decision Science, Psychology, or related fields. A course on research methods or experimental design is recommended. However, the topic may also be of interest to those studying health or design, and students in these fields are welcome.

88-410 The Global Economy: A User's Guide

Spring: 9 units

In the early years of the 21st Century, nations are more economically integrated than at any other point in human history. This presents business leaders and consumers with unprecedented

opportunities and challenges. This course seeks to equip future business leaders to exploit these opportunities and cope with these challenges. The course will accomplish that goal by providing students with a systematic understanding of the fundamental aspects of the global business environment that influence business decisions and behavior. Managers must understand the structural economic factors that determine locational advantages, the way government policies both promote and restrain the integration of national economies with the global economy, and the impact of volatility in the global macroeconomic environment on international business strategy. These issues will be studied using the analytical tools and concepts of international economics, and case studies will be used to relate these concepts to actual business problems. We will also invite international business managers to share their practical experience and insight at several points over the course of the semester.

Prerequisites: 73100 or 88220

88-411 The Rise of the Asian Economies

Spring: 9 units

For most of the past quarter century, no region of the world has been more economically dynamic than Asia. This course is designed to provide students with the essential knowledge necessary to evaluate opportunities and risks in Asia. The course will use analytical tools drawn from economics and finance, business cases, and guest lectures to focus on the key strengths that sustained economic growth in East Asia for decades, the weaknesses that undermined that growth in the late 1990s, and what lies ahead. The course will also examine Indian economic growth since the early 1980s, and compare India's experience with that of the East Asian economies. A special focus will be placed on recent developments in India and China and the prospects for continued growth in those countries over the next decade.

Prerequisites: 73100 or 88220

88-412 Economics of Global Warming

Spring: 9 units

The scientific community has concluded that human industrial activities are causing global temperatures to increase. Coping with the environmental, economic, and political consequences of this change is considered by many to be the preeminent public policy challenge of the 21st century. If ever there were a topic that required an interdisciplinary approach, this is it. Drawing upon the strong tradition of rigorous, interdisciplinary research and education at Carnegie Mellon and a broad range of expertise resident in its schools and departments, this course is designed to introduce masters students and advanced undergraduates to the many different dimensions of the global warming problem. In this course, we will investigate the science of climate change, the prospective economic impact of global warming, the uncertainty involved in long-run climate forecasting, and the technological alternatives available to us as we seek to mitigate the impact of human industrial activity on global warming. The heart of this course will be an in-depth analysis of the policy options available to the United States and the global community. We will investigate the economic costs of these options and the way political realities are likely to shape and constrain policy at the national and international levels. This course will also introduce students to the range of courses and research activities underway at CMU for those who want to study this issue in greater depth.

88-444 Public Policy and Regulation

Intermittent: 9 units

Regulations are a significant policy tool of government. How society and the economy will react to new regulations can be hard to predict. Unintended side effects sometimes occur resulting in costs exceeding estimates and/or benefits never being realized. This course will review the basics of regulatory policy and using historical examples, will explore the reasons why past regulations have succeeded and failed. The second half of the course will involve 2-3 detailed case studies. Quantitative methods will be used to evaluate several pending regulations for real-world clients from both government and industry perspectives.

88-501 SDS Senior Honors Thesis I

Fall: 9 units

Majors in the Social and Decision Sciences Department with outstanding academic records and intellectual promise will be given the opportunity to undertake original research under the direction of individual faculty members. Research topics are selected by students and faculty. Prerequisites: Senior standing; a 3.5 QPA in one of the Departments majors; a 3.25 QPA overall; permission of the Departments faculty; and approved entry into the Colleges Honors Program.

88-502 SDS Senior Honors Thesis II

Spring: 9 units

Majors in the Social and Decision Sciences Department with outstanding academic records and intellectual promise will be given the opportunity to undertake original research under the direction of individual faculty members.

Prerequisites: 88501

88-505 Undergraduate Internship

All Semesters: 3,6,9 units

An internship is an approved and monitored work experience that can be related to an academic field of study through active reflection and specific learning goals. Students must work at least 10 hours per week for the semester at the internship. Additionally, students will also keep in regular contact with a faculty member in Social and Decision Sciences, who will assign and evaluate academic work. Internships are available for 3, 6, or 9 units, depending on the type and amount of academic work produced. Students are responsible for finding their own internships and faculty sponsors, although assistance is available in the department.

Carnegie Mellon University-Wide Studies**99-101 Computing @ Carnegie Mellon**

Fall and Spring: Mini Session - 3 units

Computing@Carnegie Mellon (C@CM) is a graduation requirement for all undergraduate students. This 3-unit, pass/fail course is primarily comprised of Carnegie Mellon-specific information.

It is intended to help students understand what resources are available as well as their responsibilities as users in our computing community. The course runs for half of the semester and meets twice a week for 50 minutes. Students must pass the course with at least a 75% grade based on 3 exams, 2 assignments and attendance. Incoming students are expected to take C@CM during the fall semester. Mini 3 and 4 sections are reserved for spring transfer students and those that did not successfully complete the course previously. There are no test-out options and Advanced Placement, International Baccalaureate or college-level computing courses cannot be substituted for this requirement. C@CM is formerly known as Computing Skills Workshop (CSW).

99-102 Computing @ Carnegie Mellon

Fall and Spring: Mini Session - 3 units

Computing@Carnegie Mellon (C@CM) is a graduation requirement for all undergraduate students. This 3-unit, pass/fail course is primarily comprised of Carnegie Mellon-specific information.

It is intended to help students understand what resources are available as well as their responsibilities as users in our computing community. The course runs for half of the semester and meets twice a week for 50 minutes. Students must pass the course with at least a 75% grade based on 3 exams, 2 assignments and attendance. Incoming students are expected to take C@CM during the fall semester. Mini 3 and 4 sections are reserved for spring transfer students and those that did not successfully complete the course previously. There are no test-out options and Advanced Placement, International Baccalaureate or college-level computing courses cannot be substituted for this requirement. C@CM is formerly known as Computing Skills Workshop (CSW).

99-103 Computing @ Carnegie Mellon

Fall and Spring: Mini Session - 3 units

Computing@Carnegie Mellon (C@CM) is a graduation requirement for all undergraduate students. This 3-unit, pass/fail course is primarily comprised of Carnegie Mellon-specific information.

It is intended to help students understand what resources are available as well as their responsibilities as users in our computing community. The course runs for half of the semester and meets twice a week for 50 minutes. Students must pass the course with at least a 75% grade based on 3 exams, 2 assignments and attendance. Incoming students are expected to take C@CM during the fall semester. Mini 3 and 4 sections are reserved for spring transfer students and those that did not successfully complete the course previously. There are no test-out options and Advanced Placement, International Baccalaureate or college-level computing courses cannot be substituted for this requirement. C@CM is formerly known as Computing Skills Workshop (CSW).

99-200 Tutoring, Mentoring and Role Modeling--A Community Service Course

Spring: 6 units

This course has service, intellectual, and personal goals. Its service goal is to provide effective tutors, mentors, and role models to local public school children. Students meet for class once/week and tutor 25 hours during the semester, in a time slot of your choosing, in

programs that allow provide an opportunity to share talents and skills in the community. Many of these programs are coordinated by Carnegie Mellon departments. To promote your effectiveness, the course covers topics of tutoring (making tutoring interesting and creative, focusing on meta-learning strategies and study skills); mentoring (exploring multiple mentoring models and the mutual benefits of a mentoring relationship); and informed citizenship (gaining a broader understanding of the issues that urban kids face, exploring how public policies affect the disparities between urban and suburban school student performance). Tutors learn that they can be effective in helping younger students, and that it is personally rewarding to do so. Tutors also often express that it is refreshing to step outside the grind of Carnegie Mellon life and do something worthwhile in the community.

99-250 Seminar for Peer Tutors

Fall and Spring: 4.5 units

The purpose of this training course is to provide undergraduates with the knowledge and skills necessary to become peer tutors. Students will be exposed to the goals and objectives of the program and will gain the knowledge and experience necessary to become an effective peer tutor. Peer helpers will gain experience in group dynamics, communication skills, study strategies, referral resources, leadership, and creating a supportive learning environment. Teaching practice is an integral part of the training program. Students must complete an application in person or electronically (<http://acad-dev.mac.cc.cmu.edu/acad-dev/jobs.htm>) and then be interviewed by the instructor(s) to determine if the student possesses the basic qualifications.

99-251 Seminar for Supplemental Instruction

Fall and Spring: 4.5 units

The purpose of this training course is to provide undergraduates with the knowledge and skills necessary to become supplemental instruction (SI) leaders. Students will be exposed to the goals and objectives of the program and will gain the knowledge and experience necessary to become an effective SI leader. SI leaders will gain experience in group dynamics, communication skills, study strategies, referral resources, leadership, and creating a supportive learning environment. Teaching practice is an integral part of the training program. Students must complete an application in person or electronically (<http://acad-dev.mac.cc.cmu.edu/acad-dev/jobs.htm>) and then be interviewed by the instructor/s to determine if the student possesses the basic qualifications.

99-252 Seminar for Academic Counseling

Fall and Spring: 4.5 units

The purpose of this training course is to provide undergraduates with the knowledge and skills necessary to become peer academic counselors (AC's). Students will be exposed to the goals and objectives of the program and will gain the knowledge and experience necessary to become an effective peer academic counselor. AC's will gain experience in group dynamics, communication skills, study strategies, referral resources, leadership, and creating a supportive learning environment. Teaching practice is an integral part of the training program. Students must complete an application in person or electronically (<http://acad-dev.mac.cc.cmu.edu/acad-dev/jobs.htm>) and then be interviewed by the instructor/s to determine if the student possesses the basic qualifications.

99-451 Building Fluency for Presentations: A class for nonnative English speakers

Fall and Spring: Mini Session - 4.5 units

Building Fluency for Presentations: A class for nonnative English speakers (NNES) is a 4.5 unit pass/fail mini designed to prepare undergraduate NNES to deliver effective oral presentations. The course will help students become familiar with the expectations of the US style of presenting and will offer opportunities to practice giving presentations on academic topics. Students will focus on developing a broad range of skills, including the ability to: 1) communicate clearly with an audience in academic English; 2) employ linguistic features such as stress, intonation, and nonverbal cues to clarify and emphasize information; 3) consider various organizational strategies; 4) assess speaking strengths and weaknesses; and 5) feel comfortable in the role of presenter. Prerequisite: Permission from the Intercultural Communication Center (ICC). Please call the ICC at 412-268-4979.

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*Alumnus/a

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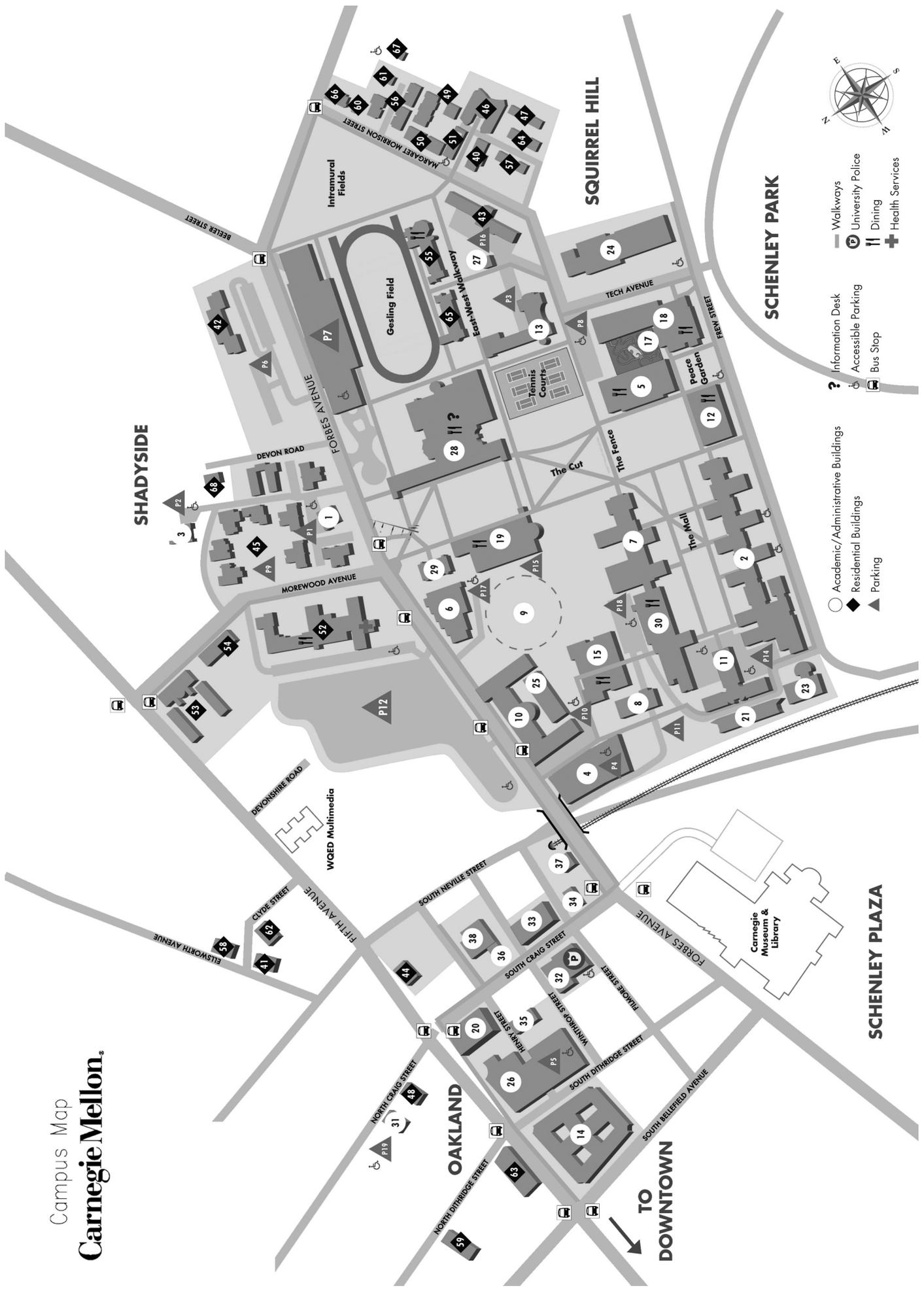
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Campus Map
Carnegie Mellon.



- Walkways
- Ⓜ University Police
- 🍴 Dining
- 🏥 Health Services

- 👤 Information Desk
- ♿ Accessible Parking
- 🚌 Bus Stop

- Academic/Administrative Buildings
- ◼ Residential Buildings
- Ⓟ Parking

SCHENLEY PLAZA

TO DOWNTOWN

○ ACADEMIC/ADMINISTRATIVE

- 1 Alumni House
- 2 Baker/Porter Hall (H&SS)
- 3 Bramer House
- 4 Collaborative Innovation Center (CIC)
- 5 College of Fine Arts (CFA)
- 6 Cyert Hall
- 7 Doherty Hall
- 8 Facilities Management Services Building
- 9 Future Site of School of Computer Science Complex, Gates Center for Computer Science and Hillman Center for Future-Generation Technologies
- 10 Hamburg Hall (Heinz School)
- 11 Hamerschlag Hall
- 12 Hunt Library
- 13 Margaret Morrison Carnegie Hall
- 14 Mellon Institute (MCS)
- 15 Newell-Simon Hall (SCS)
- 16 Pittsburgh Technology Center* (ETC)
- 17 Posner Center
- 18 Posner Hall (Tepper)
- 19 Purnell Center for the Arts
- 20 Rand Building
- 21 Roberts Engineering Hall
- 22 Robotics Engineering Consortium* (NREC)
- 23 Scaife Hall (CIT)
- 24 Skibo Gymnasium
- 25 Smith Hall
- 26 Software Engineering Institute (SEI)
- 27 Solar Decathlon House
- 28 University Center
- 29 Warner Hall (Office of Admission)
- 30 Wean Hall
- 31 Whitfield Hall (HR)
- 32 300 South Craig (Police)
- 33 311 South Craig
- 34 407 South Craig
- 35 4516 Henry (UTDC)
- 36 4609 Henry (H&SS Grad Labs)
- 37 4615 Forbes
- 38 4616 Henry (INI)
- 39 6555 Penn*

◆ RESIDENTIAL

- 40 Boss House
- 41 Cathedral Mansions
- 42 Doherty Apartments
- 43 Donner House
- 44 Fairfax Apartments
- 45 Fraternity Quadrangle
- 46 Hamerschlag House
- 47 Henderson House
- 48 London Terrace Apartments
- 49 Margaret Morrison Apartments/Plaza
- 50 Margaret Morrison Sorority Houses
- 51 McGill House
- 52 Morewood Gardens (Housing Offices)
- 53 Mudge House
- 54 New House (Stever House)
- 55 Resnik House & Tartans Pavilion
- 56 Roselawn Houses
- 57 Scobell House
- 58 Shady Oak Apartments
- 59 Shirley Apartments
- 60 Spirit House
- 61 Tech House
- 62 Veronica Apartments
- 63 Webster Hall
- 64 Welch House
- 65 West Wing
- 66 Woodlawn Apartments
- 67 99 Gladstone
- 68 1094 Devon

▲ PARKING

- ♿ P1 Alumni House***
- ♿ P2 Bramer House***
- P3 Children's School
- ♿ P4 CIC Garage**|****
- ♿ P5 Dithridge Street Garage**
- P6 Doherty Apartments***
- ♿ P7 East Campus Garage**|***
- ♿ P8 Fine Arts
- P9 Fraternities
- ♿ P10 Hamburg Hall***
- P11 Junction Hollow
- ♿ P12 Morewood***|****
- ♿ P13 Pittsburgh Technology Center* (ETC)
- ♿ P14 Porter-Hamerschlag-Wean
- P15 Purnell Center - closed for construction
- P16 Sororities
- ♿ P17 Warner
- ♿ P18 West Campus
- ♿ P19 Whitfield Hall
- ♿ P20 6555 Penn*

* Off campus, see inset

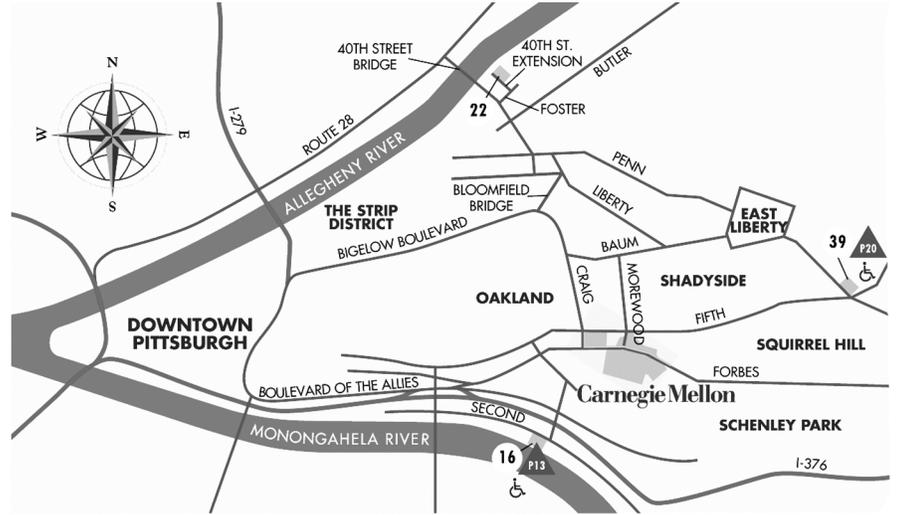
** Open to visitors 9 a.m.-5 p.m. Monday - Friday

*** Open to visitors after 5 p.m. and weekends

**** City parking meters

Additional on-street parking available on city streets.

Primary circulation routes and access parking areas are shown.



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Addendum

The addendum to this catalog will be published in the summer of 2009 and bound to the back of books distributed after August of that year. Separate copies of the addendum will be available to undergraduate students and will be distributed to faculty and administration during the fall by way of campus mail. Additional copies may be purchased at the bookstore.