48-175 Descriptive Geometry

Spring Semester • 9 units • Lectures: UT (CMB 1030) 1.30:2.50 • Recitations: TBD

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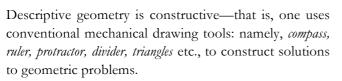
There will be a **course blackboard**
which will be mirrored on website**: http://www.andrew.cmu.edu/~ramesh/teaching/course/48-175/**

Syllabus

Descriptive geometry

Descriptive geometry deals with physical space, the kind that you have been used to since birth. Things you can see around you have geometry; and even things that you cannot do so too. All these things concern geometric objects almost always in relationship—that is, *next to*, *above*, *below*, *intersecting with*, *occluding*, *hidden by* and so on—to one another that sometimes requires us to make sense of it all—in other words, when we try to solve geometric problems albeit in architecture, engineering, or the sciences. In fact, descriptive geometry has proved itself to be practically useful; it has been one of the most important factors in the design of scientific apparatus, engineering systems and architectural structures.

Descriptive geometry started with Gaspard Monge (1746-1818). He discovered (invented!?) the principles at the tender age of 18, working as a military engineer on the design of fortifications, which were made of stones accurately cut to fit one onto another so that a wall or turret so constructed was self-supporting and strong enough to withstand bombardment.   Monge's descriptive geometry system was declared classified and a military secret and it was not until many years later around 1790s (when Monge was a Professor at the Beaux Arts) that it became declassified and a part of French engineering and architectural education and then adopted virtually universally.

Descriptive geometry is constructive—that is, one uses conventional mechanical drawing tools: namely, *compass, ruler, protractor, divider, triangles* etc., to construct solutions to geometric problems.

Descriptive geometry deals with manually solving problems in three-dimensional geometry through working with two-dimensional planes using these basic mechanical tools. This course is mainly about the techniques of solving three-dimensional geometry problems manually.

The course

The course starts off with a gentle introduction to some practical constructions just to get a sense of what one can accomplish using mechanical tools before going into details of orthographic projections and culminating in some useful applications such as casting shades and shadows and the development of surfaces.

Compass, divider and ruler, circa 17th-century, Museum of Islamic Art, Doha, Qatar

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Course topics include:

Basic Constructions

Practical methods in 2-Dimensional Geometry —Some examples—
- Measurements: lengths and area
- Constructions relating to conic sections
- Constructions based on projective mapping

Descriptive Geometry Proper

Basic Concepts of 3-Dimensional Descriptive Geometry
Points; Projection Planes; Orthographic Projection; Views; Auxiliary Views

Lines in 3-Dimensional Geometry
Intersecting lines; Skewed lines; Point view of a line; Parallel lines; Perpendicular lines; True Length of a line; Axonometric views;

Planes in 3-Dimensional Geometry
Representation; Points and lines on a plane; Edge View of a plane; Normal view of a plane; Dip of a plane;

3-Dimensional Spatial Relations on Lines
Examples—line parallel to plane; distances between lines, between planes;

Intersections
Piercing point of line and plane; line of intersection; dihedral angle; visibility;

Rotations in 3-Dimensional Space
Rotating a point about a line, a line about a line, a plane about a line; dihedral angle by rotation

Location of points and tangent planes on Solids and Surfaces
Basic techniques for locating points, piercing points, and tangent planes for common solids— examples—prisms, pyramid, cone, cylinder, sphere, and possibly oblique solids.

Shades and shadows
Based on parallel rays of light

Intersection of geometric surfaces and solids
— Of more value to engineers than to architects—though problems such as the intersection of roof geometry might be of value

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Development of surfaces
Planar unfolding of common solids, and solids with warped surfaces (useful for sheet metal work)

Axonometric and Perspective Projections
Based on orthographic projections – method of vanishing points

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Topics in the unshaded boxes—namely, the first ten and the last—will be covered in this course; development of surfaces will only be covered if time permits. Topics in boxes 2-10 constitute the bulk of descriptive geometry. The first topic gives a tasty morsel of what constructive geometry is all about.

Grading

Let me frank — I *dislike* grades. They make some people feel very good about themselves and they make others feel less good. Having said that, they are a necessary evil. The university demands it. Maybe, your parents demand it. And perhaps, some of you even demand it.

Grades do not often say much about you other than if you are smart and you do not get a good grade, then you simply didn't make the effort.

> *Learning should be fun, fulfilling and thoroughly enjoyable. In other words, make an effort.*
> *That's what my attempt at grading reflects.*

Grades are based on the following scale:

A	90-100	Excellent
B	80-90	Good
C	70-80	Fair
D	60-70	Pass
R	<60	Sorry

Grades are normally based on assignments, recitations, mid-term and final exams. As this is the first time I am teaching this course in Qatar I may make some adjustments. Questions will mainly require a geometric construction. *It will have to be correct and it will have to be clean.*

- If you show up for the assignments, you can get a maximum of 60%. If you show up for the mid-term, you can get a maximum of another 12%. If you show up for the final, you can get a maximum of a further 24%. There is 4% for performance in class, in part for attendance and in part for any mini-assignments.

> **Assignments (60%) + Midterm (12%) + Final (24%) + In-class participation (4%)**

- That is, if you ace the assignments, you pass the course. If you also ace the mid-term, you can get a C. If you also ace the final, you will ace the course. Please show up.

- **I DO NOT GRADE ON A CURVE**. If you all get A's, that is wonderful. If you all get R's, that's just the way it is. BUT … I am **human** … and if you **make an effort**—it might just push your grade slightly upwards.

Privacy rules

I follow the Buckley Amendment or FERPA rules, which means I hand back your assignments **to you and only you** in person in class, or in my office. Do not expect me to return your assignments to your classmates. **I neither discuss your work with them, nor theirs with you.**

I also **do not publicly post assignment scores or grades**.

Late Assignments

Assignments will be accepted late up to 48 hours after the deadline.

I normally apply a penalty of 1 point per problem per 12 hours. In addition to the physical copy, late assignments should be scanned and submitted via blackboard (or email) for timestamp purposes.

Textbook and anything else

I have prepared a course text, which will be placed on the blackboard. I use several books as my sources.

You will need a portable drawing board, compass, ruler, triangles, protractor, pencils, and erasers, all reasonably priced and available in the university shop(?). I will endeavor to obtain these for you. You will be expected to draw in class, especially during the assignment. Generally figure on A4 size paper for the assignments. I may require you to deal with A3 size paper for the exams.

Course duration

This is something I will find out. Typically mid-term and final exams are arranged outside class hours during exam week usually about two hours long each. There are about 14 weeks 25 lectures in all. There are 6 assignments, approximately one every two weeks.

Office hours

I do not normally have office hours. As I teach on Sundays and Tuesdays you should be able to knock on my door on Mondays and normally catch me. Otherwise, email me, if it is absolutely necessary.

Recitations

Past experience has shown that students benefit from recitation sessions. I will have to figure out how to incorporate this into your course schedule.

Attendance

I do not take attendance. However, I do not like open laptops during class – neither email nor any kind of social networking during lectures.

FAQ – why should I study a manually oriented geometry course when I can use design software to solve my geometry problems for me

No reason at all unless of course you want to become a good architect, designer, engineer/scientist with a visual affinity or will be working with spatial objects. Every good designer understands geometry and understands it well and constructively. Potentially if one is fortunate a good designer can get by with a combination of good smart design instincts and effective use of software. This course offers you a chance to become a great designer. Failing that it offers you the chance to become a good designer as the principles of descriptive geometry form the basis of geometry engines for design software. At the very least the course gives you an opportunity to become so. Descriptive geometry techniques are the basis of most computer graphics algorithms.

Finally, if you have special needs

For whatever legitimate reasons accepted by this university, I will do my best if it is within my power to help you. If not, you must contact your primary academic advisor in your home department.

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Schedule (Tentative – subject to change)

	Date	Class	Assignment	Text
Week 1	01/10	About the course		Syllabus
	01/12	Introduction to Geometric Constructions		Chapter 1
Week 2	01/17	…	Assign 1	…
	01/19	Basics of Descriptive Geometry	**due week 4**	Chapter 2
Week 3	01/24	…		…
	01/26	Lines in Descriptive Geometry		Chapter 3
Week 4	01/31	…	Assign 2	…
	02/02	Planes in Descriptive Geometry	**due week 6**	Chapter 4
Week 5	02/07	…		
	02/09	**NO CLASS**		
Week 6	02/14	Spatial Relations on Lines	Assign 3	Chapter 5
	02/16		**due week 8**	
Week 7	02/21	Review session		
	02/23	MID-TERM EXAM		
Week 8	02/28	**SPRING BREAK – NO CLASS**		
	03/01			
Week 9	03/06	Piercing points and plane intersections		Chapter 6
	03/08			
Week 10	03/13	Method of Revolution	Assign 4	Chapter 7
	03/15		**due week 12**	
Week 11	03/20	Solids and Surfaces		Chapter 8
	03/22	Locating points, tangent planes and intersections		
Week 12	03/27	Shades and Shadows	Assign 5	Chapter 9
	03/29		**due week 14**	
Week 13	04/03	Axonometric Projections		Chapter 10
	04/05			
Week 14	04/10	Central Projection	Assign 6	Chapter 11
	04/12		**due week 16**	
Week 15	04/17	Revision and exam prep		
	04/19			
Week 16	TBD	FINAL EXAM		