24-688: Introduction to CAD/CAE Tools

@ HH-B103 (Lecture)
@ BH 140E (Computer Cluster Sessions)
http://www.andrew.cmu.edu/course/24-688/
Digital Engineering Courses

24-688: Introduction to CAD / CAE Tools
24-780: Engineering Computation
24-681: Computer-Aided Design
24-682: Computer-Aided Engineering
24-688 Introduction to CAD/CAE Tools

This course offers hands-on training on how to apply modern CAD and CAE software tools to engineering design and analysis.

You will learn how to model and simulate complex 3D products using digital engineering tools.
Learning Objectives

**CAD**

- Describe the product development process
- Express product design ideas using 2D sketches
- Model a component with complex shapes
- Model an assembly of components with kinematic linkages
- Render and animate the appearance and functionality of a product

**CAE**

- Perform linear structural analysis
- Perform non-linear structural analysis
- Perform kinematic motion study analysis
- Perform Computational Fluid Dynamics analysis
- Design optimization using simulation
# Course Schedule at a Glance

<table>
<thead>
<tr>
<th>Week</th>
<th>Mon</th>
<th>Tue</th>
<th>Wed</th>
<th>Thu</th>
<th>Fri</th>
<th>Sat</th>
<th>Sun</th>
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<tr>
<td>1</td>
<td>9/26</td>
<td>No cluster hours</td>
<td>Lecture 1 (PS1 Out) Cluster Session (CP1)</td>
<td>PS1 Due Lecture 2 (PS2 Out) Cluster Session (CP2)</td>
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<td>2</td>
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<td>Cluster Session (CP1)</td>
<td>PS1 Due Lecture 2 (PS2 Out) Cluster Session (CP2)</td>
<td>PS2 Due Lecture 3 (PS3 Out) Cluster Session (CP3)</td>
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<td>PS3 Due Lecture 4 (PS4 Out) Cluster Session (CP4)</td>
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<td>PS3 Due Lecture 4 (PS4 Out) Cluster Session (CP4)</td>
<td>PS4 Due Lecture 5 (PS5 Out) Cluster Session (CP5)</td>
<td>CAD Project Out</td>
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<td>PS4 Due Lecture 5 (PS5 Out) Cluster Session (CP5)</td>
<td>Quiz 2 (PS3, PS4)</td>
<td>PS5 Due Lecture 6 (PS6 Out) Cluster Session (CP6)</td>
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<td>PS10 Due Lecture 13 Cluster Session (CP13)</td>
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<td>Thanksgiving Break</td>
<td>Lecture 14 CAD Project Presentation</td>
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Grading

- 11 Problem Sets – $3\% \times 11 = 33\%$

- 5 Quizzes – $8\% \times 5 = 40\%$

- CAD Team Project – 8%

- CAE Team Project – 8%

- Class Participation – 11%
Locations

Lectures
- Time: Thursdays 8:30am – 10:20am
- Location: HH B103

Computer Cluster Sessions
- **Session A**
  - Tuesdays & Thursdays 10:30am – 11:20am
  - Location: BH 140E

- **Session B**
  - Tuesdays & Thursdays 11:30am – 12:20pm
  - Location: BH 140E

- **Session C**
  - Tuesdays & Thursdays 12:30pm – 1:20pm
  - Location: BH 140E
Software Packages

Required Software Packages

- Autodesk SketchBook Designer
- Autodesk Inventor Professional
- Autodesk Showcase
- Autodesk Simulation Multiphysics
- Autodesk Inventor Publisher

Download the packages from:

- http://students.autodesk.com
The Instructor Team

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Hakan Kavurt (Tutor / Grader)
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Songjie Zhong (Tutor / Grader)
Email: songjie @ andrew.cmu.edu
Instructor – Prof. Kenji Shimada

- **28 years of professional experience**
  - **14 years at IBM**
    (including 4 years of graduate study at MIT, Ph.D. in Mechanical Engineering with Business Minor)
  - **16 years at CMU**
    (including 9 years of running two technology start-ups)

- Theodore Ahrens Professor in Engineering at Carnegie Mellon University
  - Mechanical Engineering (primary appointment)
  - Robotics Institute
  - Biomedical Engineering
  - Civil and Environmental Engineering

- Director of the Computational Engineering and Robotics Lab.

"Value compass": Needs x Seeds x Experiences = Values
CERLAB.
Computational Engineering & Robotics Lab.

Kenji Shimada, Ph.D.
Theodore Ahrens Professor in Engineering
Mechanical Engineering
Robotics Institute
Biomedical Engineering
Civil and Environmental Engineering

Carnegie Mellon University
Engineering
Segmentation and noise removal from a laser-digitized mesh

Sketch CAD for automobile styling design

CFD mesh generation

Layered hex meshing

Mesh adaptation for large-deformation FEM

Mid-surface meshing

Quad meshing for crash analysis

Hex-dominant meshing

Anisotropic tet meshing

Mesh adaptation for large-deformation FEM

Nesting for rapid prototyping

Adaptive CFD meshing

Cloud-based CFD

Volume decomposition

Sketch CAD for automobile seat design

Sketch CAD for industrial design

Segmentation and noise removal from a laser-digitized mesh

Quad meshing for crash analysis

Mid-surface meshing

CFD mesh generation

Texture generation

Feature generation

Mesh adaptation for large-deformation FEM

Nesting for rapid prototyping

TPSN Path Optimization

Optimization of 3D printed part

Robotics

Engineering

Product Development

Computation

Medicine

US Image synthesis

Rib-cage modeling from X-ray

Computer and robot-assisted bone-deformity correction

Aneurysm recognition

US-based prostate modeling

Modeling of abdominal aortic aneurysm from CT

Traumatic brain injury simulation

Cerebral aneurysm FSI simulation

FSI analysis of abdominal aortic aneurysm

Device optimization

Speech emotion recognition

Computer-aided tutor and planner for prostate cryosurgery

Clubfoot correction

Trachea measurement

Image-guided arthroscopic hip surgery with position-tracking

3D US for RCI

AR-assisted intubation

US-guided biopsy

Robot-assisted bone deformity correction

12 DOF legged robot

7DOF redundant robotic manipulator

UAV flight path optimization

Machine-learned robot controller

Robotic gluing

Motion teaching 3D pen

Gesture-based motion teaching

Laser digitizing for reverse engineering

Optimal path generation

Carnegie Mellon University