Course Objectives

• To learn.
  – fundamental procedures for solving engineering design problems

  – the essential details of analyzing, synthesizing, and implementing design solutions—with flexibility, adaptability, and creativity.

  – the techniques which allow an engineer to tackle new, unsolved, open-ended problems.

  – by doing through team and individual projects and assignments.
This course is about

- Professionalism
  - Projects
  - Reports
  - Attendance
<table>
<thead>
<tr>
<th><strong>Do’s</strong></th>
<th><strong>Don’t’s</strong></th>
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<tbody>
<tr>
<td>- follow instructions</td>
<td>- miss class</td>
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<tr>
<td>- be in class on time</td>
<td>- turn in hand written reports</td>
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<tr>
<td>- be in lab on time</td>
<td>- give hand written presentations</td>
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<tr>
<td>- pay attention</td>
<td>- close your minds to the alternatives</td>
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<td>- use the tools that are presented</td>
<td>- sleep in class</td>
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<td>- read the text</td>
<td>- wear a hat in class</td>
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<td>- give professional presentations</td>
<td>- bring food into studio</td>
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<td>- act professionally</td>
<td>- leave a mess in studio.</td>
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<td>- follow procedures (safety)</td>
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<td>- clean-up in lab</td>
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<td>- report damaged equipment</td>
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What is Mechanical Design?

• Process that engineering teams use to generate products that will satisfy the needs of customers

• Mechanical Design is cyclical and iterative

• WHY?
Solutions

• No single best solution
• Families of Solutions

• Eg. Hundreds of crane designs—all of which satisfy some segment of the crane market
Important Factors that determine success/failure

- Product Design
- Business
- Production

**Figure 1.1** Controllable variables in concurrent engineering.
Measuring the Design Process

Measures of effectiveness of design process

– Cost
– Quality (Performance)
– Time to Market
Measuring the Design Process

- Eg. Ford Data shows that design is only 5% of manufacturing cost, but the effect of the quality of design is much greater than 5%
Design Effect on Cost

- Study of 18 different coffeemakers
- Results of design process can change the cost of manufacturing by as much as 50%

• The decisions made during the design process have a great effect on the cost of the product but cost very little!!
• 75% of manufacturing cost is committed by the end of the conceptual phase
• Product cost is committed early in the design and spent late in the process!!

**Figure 1.4** Manufacturing cost commitment during design.
What determines quality?

• Works as it should
• Lasts a long time
• Is easy to maintain
• Incorporates the latest technology
• Has many useful features
Engineering Changes

Figure 1.6 Engineering changes during automobile development.
History of Design Process

• Over the wall
  – One way communication

• Simultaneous
  – Simultaneous development of manufacturing process with evolution of product

• Concurrent
  – Integration of teams, tools, information and processes
Design Phases

• Problem Understanding
• Specification Development
• Conceptual Design
• Detail Design
• Production Planning
• Manufacturing
• Useful lifespan
• Recycling
Product Life

Product development
- Identify need
- Plan for the design process
- Develop engineering specifications
- Develop concepts
- Develop product

Production and delivery
- Manufacture
- Assemble
- Distribute
- Install

End of life
- Retire
- Disassemble
- Reuse or recycle

Use
- Use
- Operate in sequence 1
- Operate in sequence N
- Clean
- Maintain
- Diagnose
- Test
- Repair

Figure 1.8 The life of a product.
Multiple Solutions

1. What size SAE grade 5 bolt should be used to fasten together two pieces of 1045 sheet steel which are lapped over each other (0.004m thick, 0.06m wide) loaded axially with a 100N?

2. Design a joint to fasten together two pieces of 1045 sheet steel, (0.004m thick, 0.06 wide), which are lapped over each other and loaded with 100N
Multiple Solutions

1. Analysis problem
   a. Need the correct formula, plug in values

2. Design problem
Multiple Solutions

- Design problems have many satisfactory solutions and no clear best solution
- All design problems are ill-defined
- Design problems have many satisfactory solutions and no clear best solution
- Therefore a designer must develop a machine, that by definition, has the capabilities to meet some need that is not fully defined
Problem Solving

• Establish the need
• Plan how to solve the problem
• Understand the problem by developing requirements and researching existing solutions
• Generate alternative solutions
• Evaluate the alternatives
• Decide on an acceptable solution
Design Paradox

• The more you learn the less freedom you have to use what you know

• Goal: learn as much as possible about the design early in the design process