

## ME 4010 Machine Design

- 2007 Catalog Data:** ME 4010. Machine Design. Lec. 3. Credit 3.  
Prerequisites: CEE 3110, ME 3010, and ME 3610 or consent of instructor. Tools of machine design; stress, strain, and deformation of machine parts; inherent properties of machine parts; design of machine parts for strength; design of machine parts for rigidity; introduction to finite element analysis. [Required Course]
- Prerequisites by Topic:**
1. Mechanics of materials
  2. Material science and manufacturing processes
  3. Dynamics
  4. Computer programming
- Textbook and Resources:**
- Fundamentals of Machine Component Design, Juvinall and Marshek, 3rd Ed.  
Course notes and resource material listed below.  
Machine Design: An Integrated Approach, R.L. Norton, 2nd Ed.  
Mechanical Engineering Design, J.E. Shigley and C.R. Mischke, 7th Ed.  
Roark's Formulas for Stress and Strain, W.C. Young, 6th Ed.  
Advanced Mechanics of Materials, A.P. Boresi, et al, 6th Ed.  
Mechanics of Materials, R.C. Hibbeler, 3rd Ed.
- Course Objectives:** This course is designed to familiarize Mechanical Engineering students with design for strength and rigidity, impact, and fatigue life and to introduce related analytical and computer tools. This course provides a bridge between several engineering science and mechanics courses (mechanics of materials, dynamics, and material science) and applied machine design. The unifying theme (the bridge) is the study of how mechanical components fail due to static and dynamic loading. Additionally, this course extends the student's capacity to determine stress and strain states through some advanced mechanics of materials topics and the finite element method. Finally, the course provides some design practice and problem solving in component sizing and material selection.
- Course Topics:**
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| T1. Three-dimensional stress and strain               | (10%) |
| T2. Advanced mechanics of materials                   | (15%) |
| T3. Design for strength and rigidity                  | (25%) |
| T4. Fracture mechanics                                | ( 5%) |
| T5. Design for impact loads                           | ( 5%) |
| T6. Design for fatigue life                           | (25%) |
| T7. Statistical considerations                        | ( 5%) |
| T8. Finite element analysis of bars, beams, membranes | (10%) |
- Class/Lab Schedule:** Minimum student contact time - 2200 minutes
- Course Outcomes:** Upon completion of this course, the student will be able to:
- C1. Analyze three-dimensional states of stress and strain to find principal values and maximum shear values. Recognize special cases of stress/strain states: pure shear, uniaxial, hydrostatic, plane stress, and plane strain. [a,b,e,k]
  - C2. Apply advanced mechanics of materials topics including: curved beam stresses and displacements, torsion of noncircular sections, thick-walled pressure vessels, and stress concentration factors. [a,b,e,k]
  - C3. Apply design for strength and rigidity to mechanical components and systems using failure theories for yielding, ultimate fracture, and buckling to determine factors of safety or component sizes. [a,b,c,e,l]
  - C4. Apply design for fatigue life to mechanical components and systems using the stress-life approach to determine finite life, factors of safety for infinite life, and component sizes. Understand the limitations of the stress-life approach. [a,b,c,e,l]
  - C5. Apply the displacement-based finite element method to solve for displacements and stresses in bars, beams, and membranes (constant strain triangles). [a,b,c,e,k]

And have gained experience with and/or exposure to:

- C6. Linear elastic fracture mechanics as a failure theory for materials and components that behave in a brittle manner in the presence of cracks. [a,b,e,l]
- C7. Calculation of impact loads using conservation of energy or work-energy relations.
- C8. Statistical considerations for the loading, strength, and life of mechanical components. [a,b,e,k]
- C9. Problem solving methodologies. [a,e]

**Professional Component:**

This course is required of all Mechanical Engineering students. It involves the integration of foundational course material within a limited design experience. The course is a prerequisite for ME 4020 Applied Machine Design.

**Contribution of Course to Meeting the Professional Component:**

Math and Basic Science:

General Education:

Engineering: 3 credit hours

Other:

**Relation to Program Objectives:**

Our graduates need to understand the role of mechanical failure in successful design. They must be able to bridge the gap between engineering science and mechanics courses and applied machine design. The students who successfully complete this course should have a solid foundation in the relationship between stress/strain state, material properties, and failure mechanisms. Finally, students should be more confident and productive in their problem solving skills.

**Course Coordinator:**

Undergraduate Program Committee

**Prepared by:**

Christopher D. Wilson

**Date:** 1-24-08