

**ME 561**  
**Failure Modes, Stress Analysis, and Failure Prevention Principles**  
**(5 credit hours)**

**Objectives**

1. Apply concepts of design to machines and machine elements
2. Apply a safety factor to avoid failure
3. Describe the effects of load, stress, and strain on the design of machine elements
4. Evaluate stress and strain for various types of loading
5. Determine deformations due to distributed and concentrated loads
6. Determine failures due to static loading while considering stress concentrations
7. Use fracture mechanics in considering crack extension as a function of applied static load
8. Predict failure for uniaxial and multiaxial stress states while considering static loading
9. Predict failure for cyclic loading while considering the fatigue strength and the logarithm of the number of cycles to failure

**Prerequisites**

ME 250, Numerical Methods in Mechanical Engineering  
 ME 420, Introduction Strength of Materials  
 MatSc&En 205, Introduction to Materials Science and Engineering  
 Ind Eng 311, Manufacturing Engineering; or permission of the dept.

Before taking this class, the students should specifically know:

1. Load-stress relationships and general strength of materials
2. Static force analysis and free-body diagrams
3. How to write simple programs using MATLAB
4. Basic knowledge of engineering materials and their properties
5. Basic knowledge of manufacturing processes

**Topics**

1. General Material
2. Stresses in Cylinders
3. Design for Stress and Deflection
4. Design for Dynamic Loading
5. Lab Exercises

**Basis of Grading**

1. Midterm
2. Final
3. Homework
4. Project

**General Material**

1. Types of stresses
2. Mohr's circle
3. Stress strain relationships
4. Shear and moment diagrams
5. Singularity functions
6. Flexure stresses
7. Shear stresses in beams
8. Torsional stresses
9. Stress concentrations
10. Failure theories

**Stresses in Cylinders**

1. Stresses in cylinders
  - a) Thin walled cylinders
  - b) Thick walled cylinders
2. Press and shrink fits
3. Thermal effects

**Design for Stress and Deflection**

1. Curved beams
2. Contact stresses
3. Springs
  - a) Stiffness and deflection
  - b) Tension/compression
  - c) Torsion
  - d) Beams
4. Superposition
5. Columns

**Design for Dynamic Loading**

1. Shock and impact
2. Material properties
3. Notch sensitivity and fatigue
4. Fatigue
  - a) Fluctuating stress
  - b) Combined loading
  - c) Failure loci
  - d) Cumulative damage
  - e) Fracture in fatigue
  - f) Design considerations
5. Fracture mechanics

**Lab Exercises**

1. MATLAB review
2. Solid Edge (2 Weeks)
3. Finite elements (2 Weeks)
4. Tension test
5. Experimental stress analysis
6. Fatigue tests
7. Fracture mechanics