

## **MECH 340: Mechanical Engineering Design**

**Catalog description:** 3.0 units

Design and performance of machine components and systems subjected to both steady and variable loading conditions. Introduction to failure theories, reliability, use of codes and standards, and standard design practices. 2.0 hours discussion, 2.0 hours activity.

**Prerequisites:** CIVL 311, MECH 210

**Recommended:** MECH 140, MECH 200, MECH 306, MECH 320, MFGT 160

**Course objectives:** For students to

1. Learn a process for designing mechanical systems with a balance of the conceptualization and detail design phases of the process
2. Synthesize and apply concepts from the engineering sciences including statics, dynamics, strength of materials, and materials science
3. Practice choosing parameters for a mechanical system (e.g., dimensions and material properties) based upon a set of performance specifications
4. Learn how to determine allowable stresses in a component based upon an appropriate theory of failure and a reasonable set of assumptions including factors of safety where appropriate
5. Learn how to mathematically model a selection of common mechanical components in order to predict particular performance measures and to utilize equation solving software to streamline the analytical solution process
6. Have opportunities to be creative, and at the same time, mindful of the constraints imposed by material limitations, manufacturing, standard practices, codes and standards
7. Be introduced to the concepts of uncertainty and reliability in design, as they pertain to material properties, manufacturing processes, and applied loads

**Course outcomes:** Students shall be able to

1. Apply energy methods to relate the steady-state input/output characteristics of machines to relate quantities such as torque, force, velocity, and angular velocity.
2. Determine stresses in straight, slender bodies caused by combinations of axial, shear, bending, and torsional loads
3. Determine stresses in curved beams
4. Determine miscellaneous stresses in machine components such as direct shear, tearout, and bearing stresses that occur commonly with interconnected machine parts
5. Apply stress concentration factors where appropriate
6. Determine principal stresses due to combinations of simple stress states
7. Size components using static failure theory
8. Size components using fatigue failure theory
9. Estimate and apply appropriate factors of safety for a given machine environment and loading, and apply them in selecting materials and sizing selected machine components

10. Determine the appropriate size of a rotating shaft for infinite-life strength
11. Select components such as bearings, gears, springs, threaded fasteners, clutches and brakes based on accepted practice and theory for particular machine elements

### **Topics covered**

1. Design process, codes and standards, factors of safety
2. Global analysis of machines – energy, power, and efficiency
3. Introduction to TK Solver<sup>®</sup> for algebraic equation solving
4. Strength of materials review, stresses, principal stresses
5. Simple stress states: axial, bearing, shear, torsion, bending, tear-out
6. Compound stresses, stress concentration factors
7. Static failure theories for ductile and brittle materials
8. Fatigue failure theories, stress concentrations, residual stresses
9. Surface failure
10. Selection of AC and DC motors
11. Application of design, failure modes in machine component selection:
  - Shafts, keys and couplings
  - Roller bearings, clutches and brakes
  - Threaded fasteners, power screws
12. Introduction to probabilistic design: Reliability theory in design

### **Class/Laboratory schedule**

One hundred minutes of lecture and one hundred minutes of activity per week

### **Contribution of course to meet the professional component**

This course contributes to the student's ability to work professionally in the mechanical systems area.

### **Relationship of course to Mechanical Engineering Program Outcomes**

This course contributes principally to Program Outcomes A, C, D, and E. Students must achieve a grade of C or better on the design portion of the course to pass the course and satisfy Program Outcome C.