Department of Mechanical Engineering Technology

Course number/name:

MECH 2410 Machine Design

Credits/contact hours:

4 credits, 3 class hours, and 2 lab hours

Instructor/coordinator:

Zhou Zhang, Assistant Professor of Mechanical Engineering Technology

Text book/title/author/year

Shigley's Mechanical Engineering Design, 9th edition, Richard G. Budynas and J. Keith Nisbett, McGraw-Hill, 2010, ISBN: 0073529281

Specific course information

Catalog description:

This course covers the design and selection of basic machine elements using fundamental engineering principles, in-depth analysis and design methods. The topics include the design and selection of shafts, brakes, clutches, springs, screws, bearings, cams, gears and gear trains. Students will learn how to design simple and complex mechanical components and systems. Each student should submit a term project at the end of the semester.

Pre/Corequisites:

MAT 1375, IND 2304 / MECH 2333, MECH 2335

Required/elective/selected elective:

Required for Mechanical Engineering Technology and Industrial Design Technology

Course learning objectives:

1. Mastery of the knowledge in fundamental mechanical design principles and materials failure theories.
2. Ability to apply concurrent design and engineering principles and use of the state-of-the-art CAD/CAE/CAM software.
3. Ability to identify, analyze, and solve technical problems related to the design of mechanical systems.
4. Ability to communicate effectively using appropriate designs codes and standards in homework and the design project.
5. A desire and recognition of the need to incorporate the latest technology in the course work – ability to engage in lifelong learning.
6. Ability to finish the design project with quality, to meet design deadline, to develop a continuous improvement strategy in the design project.

Course addresses ABET student outcomes:

1. An ability to apply knowledge, techniques, skills and modern tools of mathematics, science, engineering, and technology to solve well-defined engineering problems appropriate to Mechanical Engineering Technology;
2. An ability to design solutions for well-defined technical problems and assist with the engineering design of systems, components, or processes appropriate to the discipline;

3. An ability to apply written, oral, and graphical communication in well-defined technical and non-technical environments; and an ability to identify and use appropriate technical literature
4. An ability to conduct standard tests, measurements, and experiments and to analyze and interpret the results; and
5. An ability to function effectively as a member of a technical team.

Brief list of topics to be covered:

- Overview. Review of some fundamental principles. Phases of Design; Design Consideration; Codes and Standards; Stress and Strength Consideration; Factor of Safety; Reliability.

- Load and Stress Analysis. Equilibrium and Free-Body Diagram. Shear Force and Bending Moments. Stress Components, Mohr's Circle; Tri-axial Stress; Elastic Strain; Stress-strain Relations; Equilibrium; Shear and Moments; Normal Stress in Flexure; Shear Stress in Beams; Torsion; Stress Concentration; Temperature Effects; Contact Stresses.

- Deflection and Stiffness. Spring Rate, Tension, Compression, and Torsion; Flexure; Strain Energy; Castigliano's Theorem; Compression Members.

- Failure Resulting from Steady Loading. Static Strength, Maximum-Normal Stress Theory; The Maximum-Shear-Stress Theory; The Strain Energy Theory; Failure of Ductile Materials; Failure of Brittle Materials.

- Failure Resulting from Variable Loading. Introduction; Stress-Life Definitions; The Endurance Limit; The Fatigue Strength; Endurance-Limit Modification Factors; Fluctuating Stresses; Fatigue Strength Under Fluctuating Stresses

- Shafts and shaft Components. Introduction; Shaft Materials; Shaft Layout; Shaft Design for Stress; Deflection Consideration; Critical Speeds; Limits and Fits.

- Mechanical Springs. Stresses in Helical Springs; The Curvature Effect; Deflection of Helical Springs; Extension Springs; Compression Springs; Spring Materials; Design of Helical Springs.

- Rolling Contact Bearings. Bearing Types; Bearing Life; Bearing Load; Selection of Ball and Straight Roller Bearings.

- Gear Design. Types of Gears; Nomenclature; Gear Trains; Force Analysis of Spur Gears; The Lewis Formula; Surface Durability; The AGMA Stress Formulas; The AGMA Strength Formulas.

- Gearbox Design Project.

- Students will be taught to use a parametric feature based solid modeling software to create a virtual design of a gearbox. The design project will include geometric design of shafts, gears, bearings, and the gear case; kinematic, force and stress analysis, and the virtual animation of the gearbox mechanism.