# MECHANICAL ENGINEERING (ME)

# Course numbers with the # symbol included (e.g. #400) have not been taught in the last 3 years.

**ME 806 - Renewable Energy: Physical and Engineering Principles**
**Credits:** 3
The goal of this course is to become "fluent in energy" and to learn about the engineering fundamentals of renewable energy technologies. The course begins by giving an overview of U.S. energy usage and sources, as well as history and trends. Various renewable energy topics are then introduced and discussed. Where applicable, topics are discussed in detail from a fluid and thermal sciences point of view. Guest lectures and a field trip may be included. This course is open to all engineering graduate students. Prior coursework in thermodynamics and fluid dynamics required.
**Grade Mode:** Letter Grading

**ME 807 - Analytical Fluid Dynamics**
**Credits:** 4
Kinematics of flow; constitutive relationships; development of the Navier-Stokes equations; vorticity theorems; potential flow. Prior coursework in fluid dynamics required.
**Grade Mode:** Letter Grading

**ME 809 - Computational Fluid Dynamics**
**Credits:** 3
Conservation of mass, momentum, and energy, discretization and discretization schemes, boundary and initial conditions, turbulence and turbulence models, two-equation models, CFD software such as OpenFOAM, best practice guidelines for CFD. The class incorporates the use and creation of Open Educational Resources (OER)
**Grade Mode:** Letter Grading

**ME #810 - Experimental Fluid Dynamics**
**Credits:** 4
This course will introduce students to a variety of experimental methods and techniques for the measurement of fluid flow. Topics include signal processing and analysis, pressure measurement, thermal anemometry, imaging, and advanced laser based optical diagnostics. The knowledge gained in this course is intended to help students carry out advanced research in fluid mechanics at the graduate level or in an industrial research lab setting. Knowledge of Matlab programming required.
**Prerequisite(s):** ME 807 with a minimum grade of B-.
**Grade Mode:** Letter Grading

**ME 812 - Waves in Fluids**
**Credits:** 3
Linear and nonlinear dynamics of hyperbolic and dispersive wave systems with application to acoustic waves, surface and internal gravity waves, Rossby waves, and capillary waves. Key physical concepts include wave-generation mechanisms, wavelength and amplitude dispersion, group velocity and energy propagation, steady streaming, and mode interactions. Prior coursework in fluid dynamics required.
**Grade Mode:** Letter Grading

**ME 817 - Marine Robotics and Applications**
**Credits:** 3
This course covers (lecture/lab format) the broad spectrum of marine vehicles and applications, as well as what is involved in designing and building robotic vehicles for specific missions. Course topics include: marine applications, sensors for marine environments, vehicle subsystems, ocean and open water environment, dynamic modeling and control, and design/fabrication/testing. Various invited speakers (both scientists and engineers) provide learning modules on various marine robotic related topics. Graduate students will be assigned extra project work. Prior coursework in systems modeling, simulation and control required.
**Equivalent(s):** OE 817
**Grade Mode:** Letter Grading

**ME 826 - Fracture Mechanics**
**Credits:** 4
The goal is to acquaint the student with understanding of the basic principles behind the derivation of the most common linear and non-linear fracture mechanical equations. The aim is also to gain knowledge in analytical predictions of the failure of materials and become familiar with the ongoing fracture mechanical research. The motivation for this course is that many practical problems in mechanical engineering, manufacturing and materials science have to do with material deformation and failure. Prior coursework in mechanics of materials and introductory materials science required.
**Grade Mode:** Letter Grading

**ME 827 - Advanced Mechanics of Solids**
**Credits:** 4
Stress, strain, stress-strain relations, anisotropic behavior, introduction to elasticity, plane stress/strain, bending and torsion of members with general cross-sections, introduction to thin plates and shells, energy methods. Prior coursework in mechanics of materials required.
**Grade Mode:** Letter Grading

**ME 842 - Materials Processing in Manufacturing**
**Credits:** 4
Description and analysis of major material shaping processes in modern manufacturing. Casting: fluid flow and heat transfer, solidification, casting processes, properties of cast components and geometric capabilities. Forming: plasticity and formability, bulk and sheet metal forming processes, properties of formed components and geometric capabilities. Machining: cutting forces and tool wear, machining processes, properties of machined components and geometric capabilities. Overview of some non-conventional processes. Lab demonstrations. Prior coursework in mechanics of materials and introductory materials science required.
**Grade Mode:** Letter Grading

**ME 843 - Satellite Systems, Dynamics, and Control**
**Credits:** 3
General satellite systems with emphasis on spacecraft dynamics and control. Course topics include general satellite information such as types of satellites, missions, and orbits, as well as satellite subsystems. Basic spacecraft dynamics and orbital mechanics topics are covered. Advanced topics will include attitude and orbit estimation, and automatic attitude control. Prior coursework in systems modeling, simulation and control required.
**Grade Mode:** Letter Grading

**ME 872 - Control Systems**
**Credits:** 4
Development of advanced control systems design concepts such as Nyquist analysis; lead-lag compensation; state feedback; parameter sensitivity; controllability; observability; introduction to nonlinear and modern control. Includes interactive computer-aided design and real-time digital control. Lab.
**Equivalent(s):** ECE 872, EE 872
**Grade Mode:** Letter Grading

**ME 877 - Computer Aided Engineering**
**Credits:** 4
In this course, modules of Solid Works (beyond its basic solid modeling capabilities) and other software is used to demonstrate how computer based tools can be used in engineering practice, in particular design analysis and optimization. Emphasis placed on using knowledge from past engineering courses to obtain theoretical calculations to compare with the results from the computer software package. Prior coursework in strength of materials and fluid dynamics required.
**Equivalent(s):** EE 877
**Grade Mode:** Letter Grading

**ME #885 - Solid Mechanics in Manufacturing**
**Credits:** 4
Characterization of material properties will be studied with emphasis on plastic deformation. Also, numerical approaches to solve for the forces, stresses, and strains in manufacturing processes will be covered. In particular, two prominent mass production manufacturing areas, metal forming and cutting, will be examined. Prior coursework in introductory materials science and dynamics required.
**Grade Mode:** Letter Grading

**ME 886 - Introduction to Finite Element Analysis**
**Credits:** 4
Topics include basic matrix theory, potential energy approach, direct stiffness method, calculus of variations, development of finite element theory, and modeling techniques. Applications in solid mechanics, heat transfer, fluids, and electromagnetic devices, via both commercially available codes and student written codes. Prior coursework in mechanics of materials and heat transfer required. Lab.
**Grade Mode:** Letter Grading
**Special Fee:** Yes

**ME 895 - Special Topics**
**Credits:** 1-4
New or specialized courses and/or independent study. May be repeated barring duplication of subject.
**Repeat Rule:** May be repeated up to unlimited times.
**Grade Mode:** Letter Grading

**ME 899 - Master's Thesis**
**Credits:** 1-8
Master's Thesis.
**Repeat Rule:** May be repeated for a maximum of 8 credits.
**Grade Mode:** Graduate Credit/Fail grading

**ME 909 - Viscous Flow**
**Credits:** 3
Exact solutions of the Navier-Stokes equations; laminar boundary layers; wakes and jets; Stoke's flow; stability of parallel flows and boundary layers; transition to turbulence. Prior coursework in analytic fluid dynamics required.
**Grade Mode:** Letter Grading

**ME #910 - Turbulence**
**Credits:** 3
Modern analysis of turbulent flow: the governing equations; stationary random functions and the various averaging techniques; empirical results on turbulence; homogenous turbulence; the Kolmogorov theory for isotropic turbulence; upper bound theory; turbulence in the atmosphere and oceans; applications to problems in science and engineering.
**Prerequisite(s):** ME 807 with a minimum grade of B-.
**Grade Mode:** Letter Grading

**ME 922 - Continuum Mechanics**
**Credits:** 4
Cartesian tensors. Lagrangian and Eulerian description of a continuum. The material time derivative. Deformation gradient. Displacement and rotation. Strain tensors. Rates of deformation. Conservation of mass. Momentum balance equations. Cauchy and Piola-Kirchhoff stress tensors. Balance of energy: stress power, rate of work, and internal energy. Entropy and the second law of thermodynamics. Constitutive equations for elasticity and plasticity. Newtonian and non-Newtonian fluids. Inviscid and viscous flow. Naiver-Stokes equations. Ideal and rotational flows.
**Grade Mode:** Letter Grading

**ME 927 - Theory of Plasticity**
**Credits:** 4
Analysis of stress and deformation in inelastic solids; general development of stress invariants, variational principles, constitutive relations, and yield and loading functions. Special emphasis on ideal plasticity, strain-hardening, creep, limit analysis, and limit design.
**Grade Mode:** Letter Grading

**ME #935 - Micromechanics of Composite and Porous Materials**
**Credits:** 4
Classification of composites, periodic and random microstructures. Mechanics of materials approach to micro-mechanical modeling. Representative volume element, analytical and numerical modeling of the effective properties. Micromechanics of failure of composite and porous materials. Prior coursework in mechanics of composite materials required.
**Grade Mode:** Letter Grading

**ME 944 - Nonlinear Control Systems**
**Credits:** 4
Analysis and design of nonlinear control systems from the classical and modern viewpoints are discussed. Liapunov's stability theory; phase space methods; linearization techniques; simulation; frequency response methods; generalized describing functions; transient analysis utilizing functional analysis; and decoupling of multivariable systems. Prior coursework in control systems required.
**Equivalent(s):** ECE 944, EE 944
**Grade Mode:** Letter Grading

**ME 951 - Advanced Control Systems I**
**Credits:** 3
State-space representation of multivariable systems; analysis using state transition matrix. Controllability and observability; pole placement using state and output feedback; Luenberger observers. Introduction to computer-controlled systems (sampling, discrete state representation, hybrid systems): nonlinear analysis (Liapunov, Popov, describing function). Prior coursework in control systems required.
**Equivalent(s):** ECE #951, EE 951
**Grade Mode:** Letter Grading

**ME 986 - Advanced Finite Element Analysis**
**Credits:** 4
Topics include introduction to dynamics, treatment of nonlinear material behavior, and plate and shell element technology. Emphasis given to problems in solid mechanics and heat transfer. Prior coursework in finite element analysis required.
**Grade Mode:** Letter Grading

**ME 992 - Master's Project**
**Credits:** 4
The student works with a faculty member during one or two semesters on a well-defined research and/or original design problem. A written report and seminar are presented. IA (continuous grading).
**Repeat Rule:** May be repeated up to 1 time.
**Grade Mode:** Graduate Credit/Fail grading

**ME 995 - Graduate Special Topics**
**Credits:** 1-4
Investigations of graduate-level problems or topics in mechanical engineering.
**Grade Mode:** Letter Grading

**ME 999 - Doctoral Research**
**Credits:** 0
Doctoral Research.
**Grade Mode:** Graduate Credit/Fail grading
**Special Fee:** Yes