

MECHANICAL ENGINEERING (ME)

Degrees Offered: Ph.D., M.Eng., M.S.

This program is offered in Durham.

The Department of Mechanical Engineering offers degree programs at both the master's and doctoral levels. The department offers studies leading to specialization in the following six concentrations: fluid and thermal science, mechanics, materials science, design and manufacturing, dynamic systems and control, and ocean engineering.

Admission Requirements

A bachelor of science degree in mechanical engineering is normally required for admission to the graduate program in mechanical engineering. Students from other disciplines may also be admitted to the program. However, in order to be properly prepared for graduate-level coursework, these students must have taken the equivalent of the UNH mechanical engineering undergraduate core courses listed below. Students who are deficient in three or fewer courses may be admitted to the department on a provisional basis. Students who are deficient in more than three courses must apply and enroll as an undergraduate student until they meet the core course requirement. It is department policy that engineering courses taken as part of an engineering technology program are generally not considered equivalent to any of the courses listed below. The decision on equivalence for any courses taken at an institution other than UNH is at the discretion of the Graduate Committee of the Mechanical Engineering Department.

Applicants must submit current scores (within five years) from the general test of the Graduate Record Examination (GRE).

Core courses required for admission to the M.S. in mechanical engineering degree program:

Mathematics and Physics Courses

MATH 425	Calculus I	4
MATH 426	Calculus II	4
MATH 527	Differential Equations with Linear Algebra	4
MATH 528	Multidimensional Calculus	4
PHYS 407	General Physics I	4
PHYS 408	General Physics II	4

Mechanics Courses

ME 525	Statics	3
ME 526	Mechanics of Materials	3
ME 627	Dynamics	3
ME 643	Machine Design	3

Thermal Sciences Courses

ME 503	Thermodynamics	3
ME 608	Fluid Dynamics	3
ME 603	Heat Transfer	3

Other Courses

ME 561	Introduction to Materials Science	4
ME 670	Systems Modeling, Simulation, and Control	4
ECE 537	Introduction to Electrical Engineering	4

<https://ceps.unh.edu/mechanical-engineering>

Programs

- Mechanical Engineering (Ph.D.) (<http://catalog.unh.edu/archives/2017-2018/graduate/programs-study/mechanical-engineering/mechanical-engineering-phd>)
- Mechanical Engineering (M.Eng.) (<http://catalog.unh.edu/archives/2017-2018/graduate/programs-study/mechanical-engineering/mechanical-engineering-meng>)
- Mechanical Engineering (M.S.) (<http://catalog.unh.edu/archives/2017-2018/graduate/programs-study/mechanical-engineering/mechanical-engineering-ms>)

Courses

Mechanical Engineering (ME)

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. Prereq: Thermodynamics, Fluid Dynamics, or equivalent, or instructor permission.

ME 807 - Analytical Fluid Dynamics

Credits: 4

Kinematics of flow; constitutive relationships; development of the Navier-Stokes equations; vorticity theorems; potential flow. Prereq: fluid dynamics.

ME 809 - Computational Fluid Dynamics

Credits: 3

Review of matrix methods, basics of finite differences, basics of spectral methods, stability, accuracy, Navier-Stokes solvers. Prereq: heat transfer or permission.

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. Prereq: fluid dynamics; or permission.

ME 824 - Vibrations Theory and Applications

Credits: 4

Discrete vibrating systems. Linear system concepts; single-degree-of-freedom systems with general excitation. Matrix theory and eigenvalue problems. Many degrees of freedom, normal mode theory for free and forced vibration. Numerical methods; introduction to continuous systems; applications to structural and mechanical systems. Prereq: statics; dynamics or permission.

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. Prereq: strength of materials or permission.

ME 835 - Mechanics of Composite Materials

Credits: 4

Classification of composites - Anisotropy of composite materials. Micromechanical predictions of elastic and hygrothermal properties. Strength and failure of composite materials. Analysis of laminates. Experimental methods for characterization of composites. Prereq: strength of materials or permission.

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. Prereq: systems modeling or permission.

ME #860 - Physical Metallurgy I

Credits: 4

Introduction to physical metallurgy: dislocations, thermodynamics of materials, diffusion, phase transformations, and strengthening mechanisms in solids. Prereq: introduction to materials science or permission. Lab.

ME 870 - Design with Microprocessors

Credits: 4

Basic operation of microprocessors and microcontrollers explained, and interfacing these devices to sensors, displays and mechanical systems explored. Topics include: number systems, architecture, registers, memory mapping, interrupts and interfacing for system design. Methods of programming and interfacing with mechanical/electrical systems are covered and then implemented in lab. Prereq: introduction to electrical engineering. Lab.

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. Prereq: permission. (Also offered as ECE 872.) Lab.

ME 873 - Electromechanical Analysis and Design

Credits: 4

Analysis and design of electromechanical systems using lumped parameter models and magnetic finite element analysis (FEA). Electrostatic and magnetic field equations discussed and used to derive magnetic and electric lumped model elements. A brushless dc motor analyzed using lumped models and FEA. Various drive types discussed and the motor system analyzed to obtain torque-speed curves. Design principles given and utilized in a design project. Prereq: systems modeling, simulation, and control or permission.

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. Prereq: Strength of Materials; Mechanics III; Heat Transfer; and Fluid Dynamics (or equivalent); or permission.

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. Prereq: introduction to materials science, dynamics.

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. Prereq: Mechanics of Materials, Heat Transfer or permission. Special fee. Lab.

ME 895 - Special Topics

Credits: 1-4

New or specialized courses and/or independent study. May be repeated for credit.

ME 899 - Master's Thesis

Credits: 1-8

May be repeated up to a maximum of 8 credits. Cr/F.

ME 906 - Convection Heat Transfer

Credits: 4

An analytical study of heat transfer to laminar and turbulent boundary layers of compressible and incompressible fluids. Basic differential equations governing the heat transfer are derived and analytical solutions are obtained where possible and checked with experimental results.

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. Prereq: analytical fluid dynamics or permission.

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. Prereq: ME 807 or permission.

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. Navier-Stokes equations. Ideal and rotational flows.

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.

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. Prereq: mechanics of composites or permission.

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. Prereq: advanced control systems I. (Also offered as ECE 944.)

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). Prereq: control systems. (Also offered as ECE 951.)

ME 952 - Advanced Control Systems II**Credits:** 3

Special topics in control theory: continuous and discrete systems: optimal control systems, including calculus of variations, maximum principle, dynamic programming, Weiner and Kalman filtering techniques, stochastic systems, adaptive control systems. Prereq: advanced control systems I. (Also offered as ECE 952.)

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. Prereq: finite element analysis or equivalent.

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). Cr/F.

ME 995 - Graduate Special Topics**Credits:** 1-4

Investigations of graduate-level problems or topics in mechanical engineering.

ME 999 - Doctoral Research**Credits:** 0

Cr/F.

Faculty

See <http://ceps.unh.edu/faculty/mechanical-engineering> for department faculty list.