

# 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 of Mechanical Engineering offers studies leading to specialization in the following six concentrations:

- Fluid Dynamics and Thermal science
- Solid Mechanics
- Materials Science
- Design and Manufacturing
- Dynamic Systems and Control
- 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:**

Code	Title	Credits
<b>Mathematics and Physics Courses</b>		
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
<b>Mechanics Courses</b>		
ME 525	Statics	4
ME 526	Mechanics of Materials	3
ME 627	Dynamics	3
ME 643	Machine Design	3
<b>Thermal Sciences Courses</b>		
ME 503	Thermodynamics	3
ME 608	Fluid Dynamics	3
ME 603	Heat Transfer	3
<b>Other Courses</b>		
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 \(Ph.D.\)](#)
- [Mechanical Engineering \(M.Eng.\)](#)
- [Mechanical Engineering \(M.S.\)](#)

## 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.

**Grade Mode:** Letter Grade

#### 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.

**Grade Mode:** Letter Grade

#### 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 Grade

#### 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. Prereq: ME 807 or equivalent, and Matlab programming.

**Grade Mode:** Letter Grade

**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.

**Grade Mode:** Letter Grade**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. Prereq: ME 670 or equivalent.

**Equivalent(s):** OE 817**Grade Mode:** Letter Grade**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.

**Grade Mode:** Letter Grade**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. Prereq: Mechanics of Materials; Introduction to Materials Science.

**Grade Mode:** Letter Grade**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.

**Grade Mode:** Letter Grade**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.

**Grade Mode:** Letter Grade**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. Prereq: Mechanics of Materials; Introduction to Materials Science.

**Grade Mode:** Letter Grade**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.

**Grade Mode:** Letter Grade**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.

**Equivalent(s):** ECE 872, EE 872**Grade Mode:** Letter Grade**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.

**Grade Mode:** Letter Grade**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.

**Equivalent(s):** EE 877**Grade Mode:** Letter Grade

**ME 882 - Industrial Skills and Engineering****Credits:** 3

In this course, the principles of Lean Manufacturing and Value Stream Mapping (VSM) as pioneered by Toyota and now utilized by most leading manufacturers will be studied and applied. Lean Manufacturing principles will be taught with classroom instruction and a structured model factory exercise. Instruction on the theory of Value Stream Mapping (VSM) will be followed with an actual industrial VSM activity where a process will be studied and a Desired Future State defined with VSM methods. This factory floor activity will be done collaboratively with employees from a manufacturing company.

**Grade Mode:** Letter Grade**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.

**Grade Mode:** Letter Grade**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.

**Grade Mode:** Letter Grade**ME 895 - Special Topics****Credits:** 1-4

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

**Grade Mode:** Letter Grade**ME 899 - Master's Thesis****Credits:** 1-8

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

**Repeat Rule:** May be repeated for a maximum of 8 credits.**Grade Mode:****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.

**Grade Mode:** Letter Grade**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.

**Grade Mode:** Letter Grade**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.

**Grade Mode:** Letter Grade**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 Grade**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.

**Grade Mode:** Letter Grade**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.)

**Equivalent(s):** ECE #944, EE 944**Grade Mode:** Letter Grade**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.)

**Equivalent(s):** ECE 951, EE 951**Grade Mode:** Letter Grade**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.

**Grade Mode:** Letter Grade

**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.

**Repeat Rule:** May be repeated up to 1 time.

**Grade Mode:**

**ME 995 - Graduate Special Topics**

**Credits:** 1-4

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

**Grade Mode:** Letter Grade

**ME 999 - Doctoral Research**

**Credits:** 0

Cr/F.

**Grade Mode:**

## Faculty

See <https://ceps.unh.edu/directory/all> for department faculty list.