

# ENGINEERING, MECHANICAL (ENME)

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## **ENME 3511 Machine Design (3 Credits)**

Application of statics, dynamics, mechanics of materials and manufacturing processes to the design of machine elements and systems. Properties of materials and design criteria. Synthesis and analysis of a machine design project. Prerequisites: ENME 2520 and ENME 2541.

## **ENME 3545 Mechanisms (4 Credits)**

Synthesis, analysis and use of mechanisms. Mechanisms studied include cams, gears and planar linkages, with an emphasis on planar linkages. Prerequisites: ENME 2530 and ENGR 1572.

## **ENME 3651 Computational Fluid Dynamics (4 Credits)**

This course introduces principles and applications of computational methods in fluid flow and topics chosen from heat transfer, mass transfer or two phase flow. The conservation equations, their discretizations and solutions, are presented. Convergence and validity of solutions along with computational efficiency are explored. Students learn to apply these techniques using the latest software packages. Prerequisites: ENME 2671.

## **ENME 3661 Mechanical Energy Systems Engineering (4 Credits)**

This course covers energy systems engineering analysis from a mechanical and materials engineering perspective. This course covers energy production from traditional energy systems that use fossil fuel combustion such as internal combustion engines, coal-fired plants, and natural gas turbines, to nuclear energy and renewable energy methods such as wind, solar, hydraulic, and geothermal. Lastly, the course will survey emerging technologies for future (21st century) energy systems. Students should have taken at a minimum Thermodynamics, Dynamics, and Fluid Dynamics courses. Prerequisites: ENME 2720, ENME 2510, ENME 2651.

## **ENME 3720 Introduction to Aerospace Engineering (4 Credits)**

This course provides an introduction to aerospace engineering analysis and design. In the atmospheric domain, the basics of aerodynamics are covered, followed by flight mechanics. The approach is from a practical perspective in which analysis and design are intertwined. Prerequisites: ENME 2651 and ENME 2720 and ENME 2530.

## **ENME 3810 Mechanical Engineering Capstone Laboratory (3 Credits)**

This course is the capstone mechanical engineering laboratory course requiring independent experimental design by student teams. Using experimental equipment available in heat transfer, fluid mechanics, solid mechanics, thermodynamics, and measurement and control, the student team is required to design experiments to solve given problems which will be unique to each team. This course encourages students to develop experimental design and research techniques while continuing to improve skills in fundamental lab notebook keeping, uncertainty analysis in measurements, data acquisition, data analysis, report writing, oral presentations, and laboratory safety and procedures. Prerequisite: ENME 2810.

## **ENME 4020 Adv Finite Element Analysis (4 Credits)**

## **ENME 4310 Computational Methods for Mechanics and Materials (4 Credits)**

An introductory course for the general-purpose computational methods in advanced multiscale materials and mechanics. Students learn the fundamentals on the numerical methods used in mechanical and materials engineering. Cross listed with ENME 3310.

## **ENME 4360 Elasticity (4 Credits)**

Students will be able to apply the fundamental principles of elasticity to solve two- and three-dimensional mechanical engineering problems involved in modern applications of elastic structures, composite materials, tribology and contact mechanics. Dependence on previous knowledge of solid mechanics, continuum mechanics or mathematics is minimized. The emphasis is placed on the engineering applications of elasticity. Suggested prerequisite: ENME 2541.

## **ENME 4400 Fatigue (4 Credits)**

A detailed overview of fatigue. Topics include: stress life and strain life approaches, fracture mechanics, constant amplitude and spectrum loading, life prediction, fatigue at notches, microstructural effects, environmentally assisted fatigue, retardation and acceleration, multi-axial fatigue, design against fatigue and reliability. Cross listed with ENME 3400.

## **ENME 4520 Intermediate Dynamics (4 Credits)**

Development and analysis of dynamic systems through classical approaches. Topics will include: Vector algebraic/differential geometry for 3D translational and rotational kinematic analyses with motion constraints. Formulation of equations of motion for 3D multibody systems using: Newton/Euler equations; Angular momentum principle; and D'Alembert principle (aka road-maps). Some exposure to Euler-Lagrange and Kane's Methods calculations. Symbolic and numerical computational solutions to linear/nonlinear algebraic and differential equations governing the configuration, forces, and motion of systems with multiple degrees of freedom. Recommended prerequisites: MATH 2070.

## **ENME 4530 Advanced Dynamics (4 Credits)**

Formulation of equations of motion for constrained 3D multibody systems with: D'Alembert principle (MG road-maps); power, work, and energy; Lagrange's equations; and Kane's method. Euler parameters/quaternions, specified motion, constraint force/torque calculations, feed-forward control, inequality constraints and/or intermittent contact. Tensors and mass property calculations. Symbolic and numerical computer skills for geometry/kinematic analysis, mass/inertia calculations, forces and motion, and simulation of multi-body dynamic systems. Training for advanced research and professional work. Recommended pre-requisite: ENME 4520.

**ENME 4541 Advanced Mechanics of Materials (4 Credits)**

This is a second-level course in mechanics of materials with an emphasis on techniques that are useful for mechanical design. Topics may include energy methods, non-symmetrical and nonlinear bending, shear and torsion of closed and open sections, beams in elastic foundations, membrane stress in axisymmetric shells, axisymmetric bending of cylindrical shells, thick-walled cylinders and disks, curved beams, and elastic stability.

Recommended prerequisite: ENME 2541.

**ENME 4630 Viscous Flow (4 Credits)**

Course covers the fundamentals of fluid mechanics from an advanced point of view with emphasis on the mathematical treatment of viscous-flow phenomena. Topics cover the Navier-Stokes equations and its exact and similarity solutions, laminar boundary layer theory, free-shear flows, and the phenomena of instability and transition to turbulence. Recommended prerequisite: ENME 2661.

**ENME 4670 Advanced Computational Fluid Dynamics (4 Credits)**

Building on the principles and applications of computational methods in fluid flow and topics chosen from heat transfer, mass transfer and two phase flow. Specifically, Monte Carlo and volume of fluid techniques are discussed at length. Additionally, students learn how to set up automated design optimization using the latest software packages. Time permitting, students also are introduced to fluid-solid interaction modeling. Prerequisite: ENME 3651.

**ENME 4671 Convective Heat Transfer (4 Credits)**

The objective of this course is to examine the physical phenomena associated with heat transfer in the presence of fluid flow. We will develop a mathematical description of the processes (fluid flow and heat transfer) for laminar and turbulent flows for both internal and external situations. Exposure to the fundamentals of fluid mechanics and heat transfer is expected before taking this course.

**ENME 4800 Advanced Topics (ME) (0-5 Credits)**

Determined by interest and demand. May be taken more than once for credit.

**ENME 4900 Grad Professional Development (1 Credit)**

This course is required for all MME MS graduate students and all MME PhD graduate students who enter with a BS or enter with an MS but fail their first qualifying exam. One of our objectives is for all graduating students to have good written and verbal communication skills. This course is set up to meet those objectives. During this course, students write a mini-proposal and/or literature review. Students follow guidelines for a funding agency (e.g. NSF or NIH) for the mini-proposal. If students have a research advisor, students can coordinate with their advisor. If students do not have a research advisor, students may pick a topic that most interests them. Both a written proposal and an oral presentation are required of all students. Graduate standing is required.

**ENME 4950 Graduate Assessment (0 Credits)**

This graduate assessment course is required for all MME graduate students to be taken in their last quarter. All required assessment materials are uploaded to DU Assessment to meet the course requirements. Students will receive emails through the DU Assessment system notifying you of what is required to be uploaded.

**ENME 4991 Independent Study (1-10 Credits)**

**ENME 4995 Independent Research (1-16 Credits)**

**ENME 5991 Independent Study (1-10 Credits)**

**ENME 5995 Independent Research (1-16 Credits)**