Mechanical Engineering & Materials Science

Website: https://mems.wustl.edu/academics/undergraduate/index.html

Courses

MEMS 1000 Introduction to Mechanical Engineering and Mechanical Design
Mechanical engineers face new challenges in the areas of energy, materials, and systems. This course introduces students to these areas through team-based, hands-on projects that emphasize engineering design, analysis, and measurement skills.
Credit 2 units.
Typical periods offered: Fall, Spring

MEMS 1100 Machine Shop Practicum
Operation of basic machine tools including: lathe, drill press, grinder and mill. Machine tool use and safety are covered. Student shop privilege requires completion of this practicum.
Credit 1 unit.
Typical periods offered: Fall, Spring

MEMS 1110 Advanced Machine Shop Practicum
Students will learn to use the vertical machining centers (LPM and 2op), bed mill, and CNC Lathe. Conversation programming and CAD/CAM programming will be taught. Learning to load and unload tooling, set tooling offset, reconcile tools within a program, satisfy machine operational requirements, and complete safety checks will be part of the learning experience. You will learn to read G-Code and M-Code generated by the CAM program and recognize machining events in real time.
Credit 1 unit.
Typical periods offered: Fall, Spring

MEMS 1150 Computer-Aided Design
An introduction to computer aided engineering design in the context of mechanical and structural engineering. Students learn the fundamentals of spatial reasoning and graphical representation. Freehand sketching skills, including pictorial and orthographic views, are applied to the design process. Computer modeling techniques provide accuracy, analysis, and visualization tools necessary for the design of structures, devices and machines. Topics include: detailing design for production, fasteners, dimensioning, tolerancing, creation of part and assembly drawings, computer aided design, analysis and optimization of parts and assemblies; solid modeling of complex surfaces, assembly modeling, assembly constraints, and interference checking.
Credit 2 units.
Typical periods offered: Fall, Spring

MEMS 1160 Computer Aided Design - AutoCAD
AutoCAD is the most used two-dimensional drawing software for Architectural and Engineering production drawings. Introduction to AutoCAD, title blocks, drawing setup, absolute and relative coordinates, drawing entities, layouts, drafting geometry, dimensioning, plotting drawings to scale, sectional and other special views, isometric pictorial views. Classwork involves typical drawings from industry.
Credit 1 unit.
Typical periods offered: Fall

MEMS 2000 Introduction to Electrical and Electronic Circuits for Mechanical Engineering
The purpose of the course is to introduce and expand student knowledge of the field of electrical circuits. The course will be tailored to better meet the needs of Mechanical Engineering students and should not be a substitution for the traditional ESE students. The course will be a lecture/lab environment and introduce students to various concepts necessary to analyze basic electrical circuits. The main objective is to give each student a comfort level in the subject of electrical circuits, which will serve as both a basis for further study and a valuable life-long asset. Topics to be covered include: electrical energy and power, current, voltage, and circuit elements (resistors, capacitors, inductors, diodes, transistors, and operational amplifiers), Ohm's law, magnetic fields and motors, Kirchhoff's laws, Thevenin/Norton, superposition, circuit analysis, maximum power transfer, RL circuits, RC circuits, RLC circuits, filters, basic operational amplifier circuits, AC/DC power supplies, Arduino microcontroller, level shifters, I2C bus interface, stepper motor drivers, servo motor/encoder system, and PWM. The class format will be a lecture/lab combination where major lab projects will be the basis for lecture material.
Credit 3 units.
Typical periods offered: Fall, Spring

MEMS 2050 Mechanics and Materials Science Laboratory
Laboratory experiments and exercises focusing on mechanical properties of engineering materials; metallography; heat treatment; beam deflection; stress and strain measurement; properties and structure of engineering materials; calibration and use of instrumentation; acquisition, processing, and analysis of data; principles of experimentation and measurement; statistical analysis of data; preparation of laboratory reports; and presentation of data.
Credit 2 units.
Typical periods offered: Spring

MEMS 2150 Advanced Computer-Aided Design
Topics covered will include computer-aided design, analysis, and optimization of parts and assemblies; solid modeling of complex surfaces, creation of detail drawings, and dimensioning and tolerancing; assembly modeling, assembly constraints, and interference checking; motion constraints, force and acceleration analysis, and thermal analysis; and part optimization for weight, strength, and thermal characteristics using SOLIDWORKS software.
Credit 3 units.
Typical periods offered: Spring

MEMS 2210 Numerical Methods and Matrix Algebra
This course provides students with computational tools for solving mechanical, structural, and aerospace engineering problems. An introduction to MATLAB will be presented, including data input/output, program flow control, functions and graphics. Topics covered include matrices, determinants, rank, vector spaces, solutions of linear systems, interpolation and curve fitting, numeric differentiation and integration, eigenvalue and initial-value problems, nonlinear equations, and optimization. Each topic will be treated in the context of a typical engineering application.

Credit 3 units.

Typical periods offered: Spring

MEMS 2510 Statics and Mechanics of Materials

Principles of statics, solid mechanics, force systems and equilibrium. Equivalent systems of forces and distributed forces. Applications to trusses, frames, machines, beams, and cables. Mechanics of deformable solids and indeterminate problems. Stress, strain, deflection, yield and failure in beams, columns, and torsion members. * MEMS 2510 has mandatory evening exams; the specific days and times will be listed under assessments on the course section once confirmed.

Credit 3 units.

Typical periods offered: Fall

MEMS 2520 Dynamics

Review of vector algebra and calculus. Kinematics of a particle. Newton's laws and the kinetics of a particle. Work and energy. Impulse and momentum. Kinematics of rigid bodies. General theorems for systems of particles. Kinetics of rigid bodies. The inertia tensor. Computer problems form a significant part of the class.

Credit 3 units.

Typical periods offered: Fall, Spring

MEMS 2610 Materials Science

Introduction to properties, chemistry and physics of engineering materials; conduction, semiconductors, crystalline structures, imperfections, phase diagrams, kinetics, mechanical properties, ceramics, polymers, corrosion, magnetic materials, and thin films; relationship of atomic and molecular structure to physical and chemical properties; selection of materials for engineering applications; relationships between physical properties, chemical properties and performance of engineering materials.

Credit 3 units.

Typical periods offered: Spring

MEMS 3050 Fluid Mechanics and Heat Transfer Laboratory

Laboratory experiments and exercises focusing on fluid properties, flow phenomena, thermal science and heat transfer phenomena; calibration and use of instrumentation; acquisition, processing, and analysis of data; principles of experimentation and measurement; statistical analysis of data; preparation of laboratory reports; and presentation of data.

Credit 2 units.

Typical periods offered: Spring

MEMS 3110 Machine Elements

This course includes weekly lectures and a bi-weekly lab. Lectures introduce the engineering design process, review stresses and failure theories, and present a variety of machine elements (such as bearings, shafts, gears, belts, springs, etc.) and their governing equations. In lab, students use a commercial CAD package (SolidWorks) to create and constrain models of machine assemblies, analyze stresses in machine components, and create animations to demonstrate machine motion. Course material is presented in the context of a semester-long engineering design problem that culminates in a final group project. Student teams generate their own design concept to embody in CAD and characterize it with engineering and analytical models.

Credit 3 units.

Typical periods offered: Spring

MEMS 3120 Multidisciplinary Design & Prototyping

This hands-on course introduces students to the engineering design process and a variety of prototyping tools and techniques. Skills are developed through weekly studios, individual exercises, and a design project performed in small groups. Lectures focus on design principles and real-world issues for engineered products. The theme for this semester is environmental data collectors, seeking to create accurate, robust, low-cost, and easy-to-use devices that measure and record physical conditions (such as temperature, chemical content, noise, light, wind velocity, etc.) for ecological and environmental research.

Credit 3 units.

Typical periods offered: Fall

MEMS 3400 Thermodynamics

This course of classical thermodynamics is oriented towards mechanical engineering applications. It includes properties and states of a substance, processes, cycles, work, heat, and energy. Steady-state and transient analyses utilize the First and Second Laws of Thermodynamics for closed systems and control volumes, as well as the concept of exergy.

Credit 3 units.

Typical periods offered: Fall

MEMS 3410 Fluid Mechanics

Fundamental concepts of fluids as continua. Topics include: viscosity, flow fields, velocity, vorticity, streamlines, fluid statics, hydrostatic forces, manometers, conservation of mass and momentum, incompressible inviscid flow, dimensional analysis and similitude, flow in pipes and ducts, flow measurement, boundary-layer concepts, flow in open channels.

Credit 3 units.

Typical periods offered: Fall

MEMS 3420 Heat Transfer

This course provides an introductory treatment of the principles of heat transfer by conduction, convection, or radiation; analysis of steady and unsteady conduction with numerical solution methods; analytical and semi-empirical methods of forced and natural convection; boiling and condensation heat transfer; and radiation heat transfer.

Credit 3 units.

Typical periods offered: Spring

MEMS 3430 Design of Thermal Systems

Analysis and design of advanced thermo-fluid systems. Student teams participate in the design process which could involve research, design synthesis, codes, standards, engineering economics, a design project report, and formal presentations. Topics include thermo-fluid systems and components such as: power, heating and refrigeration systems; pumps, fans, compressors, combustors, turbines, nozzles, coils, heat exchangers and piping.

Credit 3 units.

Typical periods offered: Spring

MEMS 3530 Solid Mechanics

A continuation of MEMS 253 containing selected topics in the mechanics of deformable solids, presented at a level intermediate between introductory strength of materials and advanced continuum mechanics. Lectures will discuss elastic and elasto-plastic response, failure criteria, composites, beams, and structural stability, as well as an introduction of the tensorial formulation of stress and strain and the governing equations of 3-D linear elasticity. Mathematical methods from calculus, linear algebra and linear differential equations will be used. Computer problems form a significant part of the class. MEMS 255 not required.

Credit 3 units.

Typical periods offered: Fall, Spring

MEMS 4001 Fundamentals of Engineering Review

A review and preparation of the most recent NCEES Fundamentals of Engineering (FE) Exam specifications is offered in a classroom setting. Exam strategies will be illustrated using examples. The main topics for the review include: engineering mathematics, statics, dynamics, thermodynamics, heat transfer, mechanical design and analysis, material science and engineering economics. A discussion of the importance and responsibilities of professional engineering licensure along with ethics will be included.

Credit 1 unit.

Typical periods offered: Spring

MEMS 4050 Vibrations Lab

Laboratory experiments, data analysis, and simulation, focusing on vibration of mechanical systems; kinematic and dynamic response; and design of mechanisms and machine components; displacements, velocities, and accelerations in mechanical systems and components; response to static and dynamic forces; transient and steady state response; design of mechanical components for power transmission; calibration and use of instrumentation; acquisition, processing, and analysis of data; principles of experimentation and measurement; statistical analysis of data; preparation of laboratory reports and presentation of data. MATLAB will be used for data analysis and simulation.

Credit 1 unit.

Typical periods offered: Fall

MEMS 4110 Mechanical Engineering Design Project

Student groups work on an open-ended mechanical design problem and finish the semester by presenting a physical prototype and a formal report to an external review board. Groups are guided through the engineering design process by completing a set of project deliverables. The quality of these deliverables provides a basis for evaluation of individual and team performance. This course emphasizes the importance of user-centric design, communication and presentation skill, consideration of real-world constraints, sketching and creativity, prototyping, and data-driven decision making using engineering models and analyses.

Credit 3 units.

Typical periods offered: Fall

MEMS 4120 Manufacturing Processes

Manufacturing processes and machinery are explained and described. Topics include: analytical tools of machine science, heat transfer, vibrations and control theory are applied to the solution of manufacturing problems, analytical development and application of engineering theory to manufacturing problems, machine tools and automated production equipment.

Credit 3 units.

Typical periods offered: Fall

MEMS 4240 Introduction to Finite Element Methods in Structural Analysis

Application of finite element methods to beams, frames, trusses and other structural components. Modeling techniques for different types of structural engineering problems. Topics in stress analysis, applied loads, boundary conditions, deflections and internal loads, matrix methods, energy concepts, structural mechanics and the development of finite element modeling methods.

Credit 3 units.

Typical periods offered: Spring

MEMS 4310 Vibrations

Introduction to the analysis of vibrations in single- and multi- degree of freedom systems; free and forced vibration of multi-degree of freedom and distributed parameter mechanical systems and structures; methods of Laplace transform; complex harmonic balance; matrix formulation; Fourier series; and transient response of continuous systems by partial differential equations.

Credit 3 units.

Typical periods offered: Fall

MEMS 4320 Modeling, Simulation and Control

Introduction to simulation and control concepts. Topics include: block diagram representation of single-and multi-loop systems, control system components, transient and steady-state performance, stability analysis, Nyquist, Bode, and root locus diagrams, compensation using lead, lag and lead-lag networks, design synthesis by Bode plots and root-locus diagrams, state-variable techniques, state-transition matrix, state-variable feedback.

Credit 3 units.

Typical periods offered: Spring

MEMS 4999 Independent Study

Independent investigation on topic of special interest. Students must complete the Independent Study Approval Form available in the department office.

Credit 3 units.

Typical periods offered: Fall, Spring, Summer