MECHANICAL ENGINEERING (ME)

ME 504: Advanced Engineering Thermodynamics

3 Credits

Pure and applied thermodynamics including its application to advanced engineering problems; collateral reading and discussion of the classical works on the subject.

ME 512: Heat Transfer--Conduction

3 Credits

One- and two-dimensional conduction heat transfer for steady state and transient systems with varying boundary conditions.

ME 513: Heat Transfer--Convection

3 Credits

Laminar and turbulent flow heat transfer in natural and forced convection systems.

ME 514: Heat Transfer--Radiation

3 Credits

Thermal radiation fundamentals; specular and diffuse systems; differential and integral methods; numerical techniques; industrial applications.

ME 515: Two-Phase Heat Transfer

3 Credits

Heat transfer processes involving evaporation, boiling, and condensation.

ME 520: Compressible Flow II

3 Credits

Two-dimensional subsonic flow; similarity rules; theory of characteristics; supersonic and hypersonic flows; nonsteady flow; oblique shock waves.

Prerequisite: M E 420

ME 521: Foundations of Fluid Mechanics I

3 Credits

First semester of core sequence in fluid mechanics; Navier-Stokes equations, potential flow, low Re flow, laminar boundary layers.

Prerequisite: M E 300 , M E 320

ME 522: Foundations of Fluid Mechanics II

3 Credits

Second semester of core sequence in fluid mechanics; continuation of boundary layers, stability, transition, turbulence, turbulent boundary layers, turbulence models.

Prerequisite: M E 421 or M E 521

ME 523: Numerical Solutions Applied to Heat Transfer and Fluid Mechanics Problems

3 Credits

Application of finite difference methods to the study of potential and viscous flows and conduction and convection heat transfer.

ME 524: Turbulence and Applications to CFD: DNS and LES

3 Credits

First of two courses: Scalings, decompositions, turbulence equations; scale representations, Direct and Large-Eddy Simulation modeling; pseudo-spectral methods; 3 computer projects.

Prerequisite: AERSP508 or M E 521
Cross-listed with: AERSP 524

ME 525: Turbulence and Applications to CFD: RANS

3 Credits

Second in two courses: Scalings, decomposition, turbulence equations; Reynolds Averaged Navier Stokes (RANS) modeling; phenomenological models; 3 computer projects.

Prerequisite: AERSP508 or M E 521
Cross-listed with: AERSP 525

ME 530: Fundamentals of Combustion

3 Credits

Theoretical formulations and methods of solution of engineering problems and physical/chemical processes in various propulsion systems. M E 530 Fundamentals of Combustion (3) This course is devoted to the fundamentals of chemically reactive flow systems with application to modern jet, rocket, air-breathing engines, and other power generation systems. Experimental and theoretical foundations of steady-state reactions of homogeneous gas mixtures; application of mass and heat diffusion concepts to premixed and non-premixed gaseous flames, liquid-fuel droplet combustion; detonation waves, deflagration-to-detonation transition processes; ignition of gaseous mixtures. Methods for evaluation of thermal and transport properties of gases and liquids will also be discussed. While there are no prerequisites for M E 531, this course serves as a prerequisite for M E 532 (Turbulent and Two-Phase Combustion).The course will: 1) help students acquire a better understanding of the fluid flow, heat transfer, and chemical reaction processes in combustion systems by presenting a systematic description of various analyses developed for describing the fundamental processes involved in chemically reacting flow systems; 2) demonstrate the usefulness of basic principles by performing analyses and obtaining solutions for various combustion problems encountered in engineering so that individuals can utilize them to solve "real-world" problems. 3) provide graduate students with the opportunity to demonstrate their abilities to absorb new materials and to present project results to the class.It is anticipated that, upon completion of this course, students will be able to formulate models for simulating ignition and combustion problems in laminar flow conditions, solve certain types of models, and design laboratory experiments for some diagnostic measurements.Students will be evaluated on the basis of class participation (5%), homework 20%), quizzes (5%), projects (25%), a mid-semester examination (20%) and a final examination (25%).M E 531 will be offered each spring with an anticipated enrollment of 12 students; M E 532 will be offered each fall with an anticipated enrollment of 12.

ME 532: Turbulent and Two-Phase Combustion

3 Credits

Fundamentals of chemically reacting turbulent flows in homogeneous systems including turbulent flames, spray combustion, ignition, reacting boundary layers. M E 532 Turbulent and Two-Phase Combustion (3) M E 532 is the second course of two-course sequence. Continuing where M E 531 (Fundamentals of Combustion) left off, this course is devoted to the fundamentals of chemically reacting turbulent flows in both homogeneous and heterogeneous systems with special emphasis on turbulent flames in gases; heterogeneous combustion; chemical reactions in boundary-layer flows; spray combustion of liquid fuel droplets; two-phase combustion of solid particles; and, ignition of gaseous mixtures and condensed phases.Upon completion of this course, students should be able to: 1) formulate a theoretical model to simulate a combustion problem, based upon knowledge of existing research. 2) identify the major mechanisms involved in a given combustion problem. 3) design a laboratory-scale test apparatus and test matrix to observe combustion phenomena and to take measurements. 4) interpret experimental results in terms of the trend of operating parameters. 5) validate the model using the experimental data and observations. 6) evaluate the merit of a model or experimental design presented in a technical article. 7) analyze realistic combustion problems using the basic principles of combustion and state-of-the-art technology.Students will be evaluated on the basis of homework (20%), projects (25%), a mid-semester examination (25%), a final examination (25%), and class participation (5%).M E 531 will be offered each spring with an anticipated enrollment of 12 students; M E 532 will be offered each fall with an anticipated enrollment of 12.

Prerequisite: F SC 421 or M E 430 or M E 531

ME 535: Physics of Gases

3 Credits

An introduction to kinetic theory, statistical mechanics, quantum mechanics, atomic and molecular structure, chemical thermodynamics, and chemical kinetics of gases.

Cross-listed with: AERSP 535

ME 537: Laser Diagnostics for Combustion

3 Credits

A study of laser-based techniques for measuring gas temperature and concentration in chemically reacting flows.

Prerequisite: M E 535

ME 545: Mechatronics

3 Credits

This class will facilitate the hands-on investigation of mechatronic systems using a problem-based approach, with specific focus on system-level implementations. M E 545 Mechatronics (3) This class will facilitate hands-on investigation and learning of mechatronic systems using a problem-based approach. The course consists of lectures, lab activities, and major projects that train students to develop system-level implementations of mechatronics. This course complements and builds on the existing undergraduate-level microcomputer interfacing course, which presents model-free design of single-processor, single-sensor, single-task, and/or single actuator mechatronic systems. This course focuses on model-based design of multi-processor, multi-sensor, multi-actuator, and multi-tasking mechatronic systems. Students are expected to be familiar with systems and signals analysis including Laplace transforms, Eigenvalues, Bode plots, stability margins, basic feedback loop performance and stability analysis, etc. Students should have a firm understanding of electrical circuits and structured programming. Nearly all assignments will require the use of MATLAB and/or some C-style programming.

Prerequisite: M E 445

ME 546: Designing Product Families

3 Credits

Product families, product platforms, mass customization, product variety, modularity, commonality, robust design, product architectures. I E (M E) 546 Designing Products Families (3) Designing Product Families is a graduate-level course generally offered in the spring. It is designed for students interested in product realization, engineering design, and manufacturing to gain an understanding of mass customization and methods for designing families of products based on modular and scalable product platforms. The transition from craft production to mass production to mass customization will be covered in this course along with methods and tools for designing robust, modular, and scalable product platforms. Platform leveraging strategies and commonality metrics will be investigated through product dissection activities, which will also be integrated with lectures on evaluating manufacturing and assembly. Several industry case studies will also be discussed in the course to examine the implications of producing a variety of products and strategies for effective mass customization and product postponement.Students interested in taking this course should be familiar with product design and manufacturing.Students are evaluated through individual and group homework assignments, in-class participation and activities, and a group project report and presentation.

Prerequisite: M E 414 or M E 415 or I E 466
Cross-listed with: IE 546

ME 547: Designing for Human Variablility

3 Credits

Statistics, optimization, and robust design methodologies to design products and environments that are robust to variability in users.

Cross-listed with: EDSGN 547

ME 550: Foundations of Engineering Systems Analysis

3 Credits

Analytical methods are developed using the vector space approach for solving control and estimation problems; examples from different engineering applications. E E (M E) 550 Foundations of Engineering Systems Analysis (3) This 3-credit course is offered at the first-year graduate level and provides a systems-theoretic background for more advanced graduate courses in the disciplines of engineering and science. The course uses the vector space approach to develop the analytical foundations for solutions of science and engineering problems in diverse application areas such as optimal control, estimation, and signal processing. First, the theoretical foundation of vector spaces, function spaces, and Hilbert spaces are developed. Linear transformations are then introduced, followed by the Reisz-Frechet theorem and Hahn-Banach theorem, with applications to optimization problems. Spectral analysis is then covered. Finally, diverse applications of these various techniques are presented throughout this course to illustrate the wide range of engineering problems that can be solved using the vector space approach.

Prerequisite: MATH 436
Cross-listed with: EE 550

ME 551: High Power Energy Storage

3 Credits

High-power energy storage technologies including advanced batteries, ultracapacitors, and flywheels. E SC (M E) 551 High Power Energy Storage (3) The course focuses on high-power, in-vehicle energy storage technologies used in hybrid electric vehicles, including advanced batteries, fuel cells, ultracapacitors, and flywheels. An interdisciplinary approach with mechanical, materials, electrical, and chemistry-based concepts provides the foundation to understand the operation and application of these energy storage devices. The course provides a synopsis of hybrid electric and fuel cell vehicle design, control, and simulation to determine the effect of energy storage components on performance and fuel efficiency.

Cross-listed with: ESC 551

ME 552: Optimal Control of Energy Systems

3 Credits

This course provides an overview of the fundamental principles and methods of optimal control, dynamic programming, and extremum-seeking control, with a focus on the application of these tools to a variety of problems in the energy generation, storage, and management domain. Fundamental topics covered include bond graph modeling of energetic systems, constrained and unconstrained static optimization, the Karush-Kuhn-Tucker conditions, extremum-seeking control, the Bellman principle of optimality, deterministic dynamic programming, Markov chains, stochastic dynamic programming, the Bolza optimal control problem, the Pontryagin maximum principle, the Hamilton-Jacobi-Bellman equation, linear quadratic regulation, bang-bang control, and pseudo-spectral optimal control. Applications examined include impedance matching in photovoltaics and wind power plants, fuel-minimizing optimal vehicle path planning, optimal Lithium-ion battery charging/discharging, optimal power management in hybrid electric and hybrid hydraulic vehicles, and optimal building energy management. The course serves as a broad overview of fundamental topics covered in more depth in other classes on dynamic programming, adaptive control, and optimal control. Equal emphasis is placed on the tools and methods of optimal control theory and their practical application to optimal energy management problems. The course is intended for graduate students in engineering interested in energy management research, and already possessing a basic familiarity with energy systems and dynamic system modeling.

Prerequisite: ME 450

ME 554: Digital Process Control

3 Credits

Analysis and design of control systems with digital controllers, including PID, finite settling time, state feedback, and minimum variance algorithms.

Prerequisite: M E 450 , M E 455

ME 555: Linear System Theory and Control

3 Credits

Advanced problems and techniques in the design of automatic control systems with emphasis on stability, controller design, and optimum performance. M E 555 Linear System Theory and Control (3) This course examines problems and techniques in the analysis and design of linear systems. The course assumes a fundamental background in dynamic system modeling and frequency-domain SISO control input analysis and design. Topics include: vectors and vector spaces; Eigenvalues and Eigenvectors; the Cayley-Hamilton theorem; Jordan canonical forms; internal and BIBO stability; Lyapunov stability analysis; observability and controllability; similarity transformations, state-space realization, and observer/controller canonical forms; pole placement; elementary observer and state-feedback controller design; the separation principle; Kalman filtering; and linear quadratic regulation.

Prerequisite: M E 455

ME 556: Robotic Concepts

3 Credits

Analysis of robotic systems; end effectors, vision systems, sensors, stability and control, off-line programming, simulation of robotic systems.

Prerequisite: I E 456 or M E 456
Cross-listed with: IE 556

ME 558: Robust Control Theory

3 Credits

Fundamentals of Robust Control Theory with emphasis on stability, performance analysis, and design.

Prerequisite: E E 580 or M E 555
Cross-listed with: EE 584

ME 559: Nonlinear Control and Stability

3 Credits

Design of nonlinear automatic control systems; phase-plane methods; describing functions; optimum switched systems; Liapunov stability; special topics in stability.

Prerequisite: E E 380
Cross-listed with: EE 587

ME 560: Solid Mechanics

3 Credits

Introduction to continuum mechanics, variational methods, and finite element formulations; application to bars, beams, cylinders, disks, and plates. E MCH (M E 560) 500 Solid Mechanics (3) This course introduces students to the fundamental principles and basic methods used in solid mechanics. Using indicial notation and integral formulations provides a foundation for more advanced study in continuum mechanics (E MCH 540) and finite element analysis (E MCH 560) specifically and in mechanics in general. The materials behavior is restricted to linear elastic and the emphasis is on stress analysis. Students are expected to have an understanding of elementary mechanics of materials (such as E MCH 013).The course objectives are to: 1) provide students with a firm foundation in solid mechanics. 2) introduce continuum mechanics concepts, variational methods, and the formulation used in finite element analysis. 3) enable students to formulate and solve the boundary value problems commonly encountered in the analysis of structures.The study of solid mechanics starts with the definition of stress and strain and how the two are related by material law. Field equations that relate strain to displacement, ensure a single valued displacement field, and the balance momentum are formulated. These are partial differential equations that can only be solved subject to known boundary and initial conditions. The field equations and boundary conditions comprise a boundary value problem that is usually difficult to solve exactly. Variational methods are used to bound or approximate the solution. The finite element method employs variational methods to formulate generic elements and is a computational tool for solving boundary value problems for complex geometries.

Cross-listed with: EMCH 500

ME 561: Structural Optimization Using Variational and Numerical Methods

3 Credits

Shape and size optimization of elastic structures, continuous and discrete solution methods and numerical algorithms, design of compliant mechanisms. ME 561 Structural Optimization Using Variational and Numerical Methods (3) Optimal Structural Design is a graduate-level course generally offered in spring semester. The course is designed for graduate students in mechanical engineering or related fields who have already taken a course in finite element analysis. The course covers techniques in structural optimization from classical variational-based methods to modern numerical and finite element-based methods. Topics include shape and size optimization of elastic structures, continuous and discrete methods for least weight maximum stiffness design, solution using optimality criteria methods, structural topology optimization, gradient-based solution methods and numerical algorithms, and design project(s) using these methods. Methods are applied to examples such as beam and truss structures, compliant mechanisms, and piezoelectric actuators.Computer programming skills using software such as Matlab are required. Students are evaluated based on homework assignments, review and presentation of articles from the literature, class participation, and a group design project.

Prerequisite: M E 461

ME 563: Nonlinear Finite Elements

3 Credits

Advanced theory of semidiscrete formulations for continua and structures; emphasizes dynamic and nonlinear problems.

Prerequisite: A B E513 , E MCH461 , or E MCH560
Cross-listed with: EMCH 563

ME 564: Elastic and Dynamic Stability of Structures

3 Credits

An introduction to the concept and analysis methods of structural stability; structures under static/dynamic loading and high speed conditions.

Prerequisite: E MCH213 , M E 450 ; students need to have basic understanding of mechanical behavior of materials to follow the equations in this course, and basic concepts of system stability to expand them to elastic structures

ME 565: Optimal Design of Mechanical and Structural Systems

3 Credits

Application of numerical optimization techniques to design mechanical and structural systems; design sensitivity analysis.

ME 566: Metal Additive Manufacturing Laboratory

3 Credits

This course will provide in-depth and hands-on laboratory experience in metal-based additive manufacturing. The laboratory activities will expose students to all aspects of the additive manufacturing workflow for metal components, starting with conceptual design, proceeding through fabrication, post-processing, and part inspection. Laboratory activities will include part design and analysis, process simulation and modeling, build preparation and machine set up, fabrication and post-processing, and non-destructive inspection and measurement. Laboratories will include computational design tools and simulation models as well as fabrication and post-processing (e.g., heat treatment, machining). Finally, the laboratory activities will also stress safe powder handling, equipment, and laser safety, which is particularly important when working with metallic powders and feedstocks. The laboratory is intended for students that have a basic understanding of the different additive manufacturing processes and are gaining familiarity with the engineering and science of additive manufacturing. The laboratory activities will provide students with the scientific foundation and research skills necessary to rigorously ascertain the performance of additively manufacturing materials, processes, and parts. Upon completion of the laboratory, students should be able to describe the workflow for additive manufacturing, identify main cost drivers, and describe the differences when using metals versus polymers. They should also understand the key tradeoffs between design, manufacturing, and materials as it relates to the additive manufacturing processes utilized in the laboratory activities.

Prerequisite: IE 587 CONCURRENT: ESC 545

ME 571: Foundations of Structural Dynamics and Vibration

3 Credits

Modeling approaches and analysis methods of structural dynamics and vibration.

Prerequisite: AERSP304 , E MCH470 , M E 450 , or M E 570
Cross-listed with: AERSP 571, EMCH 571

ME 572: Experimental Modal Analysis

3 Credits

The development of structural dynamic models from experimental data, analytical and experimental vibration, analysis methods, laboratory techniques.

Prerequisite: M E 450

ME 577: Stochastic Systems for Science and Engineering

3 Credits

The course develops the theory of stochastic processes and linear and nonlinear stochastic differential equations for applications to science and engineering.

Prerequisite: MATH 414 or MATH 418 ; M E 550 or MATH 501
Cross-listed with: MATH 577

ME 578: Theory and Applications of Wavelets

3 Credits

Theory and physical interpretation of continuous and discrete wavelet transforms for applications in different engineering disciplines.

Prerequisite: M E 550 or MATH 501
Cross-listed with: MATH 578

ME 580: Advanced Dynamics of Machines

3 Credits

Linear and torsional vibrations in and balancing of rotating and reciprocating machinery; exact analysis of stresses produced by these and other dynamic forces in machine parts.

ME 581: Simulation of Mechanical Systems

3 Credits

Introduces computational fundamentals, including digital logic; programming language, basic numerical analysis and data processing, as applied to mechanical simulation techniques.

Prerequisite: M E 480

ME 590: Colloquium

1 Credits

Continuing seminars that consist of a series of individual lectures by faculty, students, or outside speakers.

ME 596: Individual Studies

1-9 Credits/Maximum of 9

Creative projects, including nonthesis research, which are supervised on an individual basis and which fall outside the scope of formal courses.

ME 597: Special Topics

1-9 Credits/Maximum of 9

Formal courses given on a topical or special interest subject which may be offered infrequently.

ME 600: Thesis Research

1-15 Credits/Maximum of 999

No description.

ME 601: Ph.D. Dissertation Full-Time

0 Credits/Maximum of 999

No description.

ME 602: Suprvised Experience in College Teaching

1-3 Credits/Maximum of 6

For graduate students helping to teach the beginning thermodynamics course, M.E. 22. Must have taken M.E. 504.

ME 610: Thesis Research Off Campus

1-15 Credits/Maximum of 999

No Description.

ME 611: Ph.D. Dissertation Part-Time

0 Credits/Maximum of 999

No description.