
ME Mechanical Engineering

- ME 101 INTRODUCTION TO MECHANICAL ENGINEERING. (3)**
This course introduces the Mechanical Engineering profession including the skills and expectations required for success. Engineering applications of calculus are also presented. Prereq or concur: MA 113.
- ME 205 COMPUTER AIDED ENGINEERING GRAPHICS. (3)**
Combines freehand sketching techniques, both orthographic and pictorial, and the use of a solid modeling program to describe and define mechanical objects using current industrial standards. An introduction to basic dimensioning and tolerancing techniques is included.
- *ME 220 ENGINEERING THERMODYNAMICS I. (3)**
Fundamental principles of thermodynamics. Prereq: PHY 231; coreq: MA 213.
- ME 251 INTRODUCTION TO MATERIALS AND MANUFACTURING PROCESSES. (3)**
A background course in the areas of materials and manufacturing processes for mechanical engineers. Includes basic microstructure of materials, material properties and processing. Also includes an overview of casting, metal forming, machining, additive processing, non-traditional manufacturing processes, and manufacturing of non-metallic components. Prereq: MA 113, CHE 105.
- ME 310 ENGINEERING EXPERIMENTATION I. (3)**
An introductory course in measurement and instrumentation emphasizing measurement errors, elementary statistics, uncertainty analysis, sensors, time and frequency response of instrumentation components, signal conditioning circuitry, and digital data acquisition. Applications include the measurement of strain, pressure, temperature, flow, force, torque, and vibration. Lecture, two hours; laboratory, three hours. Prereq: ME 101, ME 330, EE 305 and engineering standing. Prereq: ME 330, EE 305 and engineering standing. Prereq or coreq: ME 340.
- ME 311 ENGINEERING EXPERIMENTATION II. (3)**
A laboratory to instruct the student in the performance of basic mechanical engineering components and systems. Performance of experiments, application of theory and reporting. Introduction to error analysis, and design and planning of experiments. Lecture, one hour; laboratory, four hours. Prereq: ME 310, 321, 325 and engineering standing.
- ME 321 ENGINEERING THERMODYNAMICS II. (3)**
Gas mixtures, air-water vapor mixtures. Air conditioning system design. Principles and design of energy conversion devices, power and refrigeration cycles. Principles of combustion, chemical equilibrium, one-dimensional gas dynamics. Nozzle design. Continuation of ME 220. Prereq: ME 220, MA 214, and engineering standing.
- ME 325 ELEMENTS OF HEAT TRANSFER. (3)**
Fundamental principles of conduction, convection, radiation heat transfer. Numerical methods for heat transfer problems. Design and applications of heat transfer equipment such as fins and heat exchangers. Prereq: ME 330, MA 214, and engineering standing.
- ME 330 FLUID MECHANICS. (3)**
Introduction to the physical properties of fluids, fluid statics. Equations of conservation of mass, momentum and energy for systems and control volumes. Dimensional analysis and similarity. Principles of inviscid and real fluid flows including derivation and application of the Navier-Stokes equations. Flow through pipes and around bodies. Application and design of fluid handling systems. Prereq: Engineering standing, ME 220, and MA 214.
- ME 340 INTRODUCTION TO MECHANICAL SYSTEMS. (3)**
Modeling of mechanical, thermal, hydraulic and electrical systems, and other phenomena from a systems viewpoint. Analysis of continuous-time models for free and forced response. Laplace transforms and transfer functions. Introduction to numerical simulation. Analysis of higher-order systems. Prereq: MA 214, and engineering standing. Coreq: EM 313.
- ME 344 MECHANICAL DESIGN. (3)**
Fundamentals of design with methods of approximation. Introduction to optimum design considerations. Synthesis and problems on the design of various mechanical elements. Prereq: ME 151 or ME 251, EM 302, engineering standing; concur: EM 313.
- ME 358 ECONOMIC ANALYSIS OF MECHANICAL SYSTEMS. (3)**
Formulation of economic relationships. Familiarization with alternate mechanical systems and application of economic principles of selection of alternates. Prereq: ME 321, engineering standing or consent of instructor.

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ME 380 TOPICS IN MECHANICAL ENGINEERING (Variable topics). (3)

A lecture-recitation course on a topic of current interest. Modern developments in mechanical engineering will be stressed. Offered as a technical elective in mechanical engineering. May be repeated to a maximum of nine credits. Prereq: Variable, given when topic identified and engineering standing.

ME 395 INDEPENDENT WORK IN MECHANICAL ENGINEERING. (1-3)

Special research and problems for individual students who wish to pursue independent investigations. Variable credit: may be repeated to a maximum of six credit hours for technical electives. A final report is required. Prereq: Consent of department chairperson via permit.

***ME 411 ME CAPSTONE DESIGN I. (3)**

The first semester of the capstone design sequence in mechanical engineering. Topics important in product design and manufacturing are included, including consideration of economics, safety, and communication. Students will develop a project plan concerned with the design of a complex system of current interest to mechanical engineers. Students will work in small groups and emphasis will be on original work. Lecture, two hours; laboratory/independent team work, three hours per week. Prereq: Engineering standing; prereq: EM 313, ME 205, ME 310, ME 325, ME 340, ME 344.

ME 412 ME CAPSTONE DESIGN II. (3)

Second semester of the capstone design sequence in mechanical engineering. Students will complete a project concerned with the design of a complex system of current interest to mechanical engineers. Students will work in small groups and emphasis will be on original work. Topics include engineering ethics, design and communication. Lecture, 1 hour; lab 4 hours per week. Prereq: ME 411 and engineering standing. Course is to be taken semester immediately following ME 411.

#ME 416 AUTOMOTIVE PAINTING TECHNOLOGY. (3)

The course will introduce students to the automotive painting process and technology, and its impact on color, appearance, coating quality, and corrosion prevention. These include pretreatment, electrodeposition, sealers/PVC, Primer, and topcoat with emphasis on material selection and technology implementation. Prereq: Engineering Standing. ME 321, ME 330 or enrollment in the Production Engineering Certificate.

#ME 418 AUTOMOTIVE ASSEMBLY AND QUALITY CONTROL. (3)

This course will focus on automotive assembly and production processes. During the assembly process, the vehicles are inspected to meet the manufacturer quality. In this course students, will be able to identify possible defects sources and methods to inspect and evaluate the processes using nondestructive techniques. The students will be learning both theoretical and practical principles using a combination of class and laboratory lectures. Prereq: Engineering Standing, ME 340 or enrollment in the Production Engineering Certificate.

ME 440 DESIGN OF CONTROL SYSTEMS. (3)

Fundamentals of classical control theory. Mathematical representation of feedback control systems using block diagrams and transfer functions. Design and analysis of feedback control systems using root-locus, Nyquist, and Bode methods to ensure system stability and meet desired system response specifications. Numerical simulation of feedback control systems. Prereq: ME 310, ME 340 and engineering standing.

ME 480G HEATING, VENTILATING AND AIR-CONDITIONING. (3)

An introductory course emphasizing the engineering systems aspects of thermal environmental design. Principles and applications of building energy requirements and thermal comfort criteria. Prereq: ME 325 and Engineering standing or consent of instructor. (Same as AEN 480G.)

ME 501 MECHANICAL DESIGN WITH FINITE ELEMENT METHODS. (3)

This course emphasizes mechanical design techniques based on the finite element method, using machine design background as the starting point. Techniques for modeling machine elements will be shown in relation to the basic FEM theory. Emphasis will be on quantifying loads, the resulting stress and deflection, and relating them to design allowables, leading to an acceptable design solution. Prereq or concur: Engineering Standing, ME 344 and ME 205; or Graduate standing or consent of instructor. (Same as MFS 501.)

ME 503 LEAN MANUFACTURING PRINCIPLES AND PRACTICES. (3)

This course will introduce students to the fundamental concepts of production improvement utilizing lean manufacturing principles and practices. In addition to the lectures, web-based simulations/experiments/games will be used to help learn the application of the tools supported by industry case studies. A Capstone Simulation will be used to demonstrate the collective application of all the tools and techniques (details included below). An application project is also included where students will work in teams to study a real-life manufacturing or service environment to assess the current state, identify improvement opportunities and develop countermeasures for implementation. Prereq: Engineering standing or with instructor permission. (Same as MFS 503.)

ME 505 MODELING OF MANUFACTURING PROCESSES AND MACHINES. (3)

This course is aimed at providing the undergraduate and graduate students in mechanical and manufacturing engineering basic knowledge and understanding of the major manufacturing processes for modeling, monitoring and control of these processes through a series of analytical and experimental techniques and tools, including group work for assignments and experiments. Prereq: EM 302, EM 313, and engineering standing; or graduate standing with instructor consent. (Same as MFS 505.)

ME 506 MECHANICS OF COMPOSITE MATERIALS. (3)

A study of the structural advantages of composite materials over conventional materials, considering high strength-to-weight and stiffness-to-weight ratios. Fiber reinforced, laminated and particulate materials are analyzed. Response of composite structures to static and dynamic loads, thermal and environmental effects, and failure criteria are studied. Prereq: EM 302, engineering standing or consent of instructor. (Same as EM/MSE 506.)

ME 507 DESIGN FOR MANUFACTURING. (3)

This course will provide a strong foundation in the concepts, theories and applications of design engineering methodologies for effective manufacture of high quality products at low costs and high productivity. In addition to the lectures, the assembly and design analysis of “product based assembly kits” will be used to apply and help learn the tools presented in class. The final project includes the application of these tools to re-design a given product from a manufacturing and assembly perspective. Prereq: ME 344 or instructor permission. (Same as MFS 507.)

ME 510 VIBRO-ACOUSTIC DESIGN IN MECHANICAL SYSTEMS. (3)

Application of basic acoustics and vibrations to engineering problems in vibro-acoustic design. The objective is to acquaint the student with the tools used in industry for noise and vibration control and to make the student aware of the major applications of such tools in the automotive, aerospace, and consumer product industries. Prereq: ME 310, ME 340. This course is open only to graduate students or undergraduates with engineering standing.

ME 512 MANUFACTURING SYSTEMS. (3)

This course introduces students to fundamentals of design, planning and control of manufacturing systems aided by computers. Concepts of control hardware, NC programming languages, software aspects related to NC manufacturing, programmable controllers, performance modeling of automated manufacturing systems, group technology and flexible manufacturing systems, etc. will be addressed. Prereq: Engineering standing. (Same as MFS 512.)

ME 513 MECHANICAL VIBRATIONS. (3)

The analysis of vibrational motion of structural and mechanical systems. Single-degree-of-freedom systems; free vibrations; nonperiodic excitation; harmonic excitation. Modal analysis of multiple-degree-of-freedom systems. Vibration of continuous bodies, including strings and bars (axial, torsional and flexural modes). Energy methods. Prereq: EM 313 and EM 302, engineering standing or consent of instructor. (Same as MFS 513.)

ME 514 COMPUTATIONAL TECHNIQUES IN MECHANICAL SYSTEM ANALYSIS. (3)

Computer-based methods of analyzing mechanical systems are studied. The studies include the numerical solution techniques on which the analyses are based. Linear and nonlinear static and dynamic systems are analyzed. Finite element and other engineering software packages are used. Prereq: ME 340. This course is open only to graduate students or undergraduates with engineering standing.

ME 515 ROTORDYNAMICS OF TURBOMACHINERY. (3)

Review of dynamic characteristics unique to high speed rotating shafts in turbomachinery. Equations of motion for a rotor, including gyroscopic effects; computational methods, including finite element; effects of bearings and nonlinearities, stability; application to design situations in high-speed equipment, including aerospace, energy generation, and other industrial applications. Prereq: EM 313 and Engineering standing; pre/co-requisite for Western Kentucky University students: ME 415 and ME 344; pre/co-requisites for UK students: ME 344 and ME 501; or Graduate Standing or consent of instructor. (Same as MFS 515.)

ME 516 SYSTEMS ENGINEERING. (3)

Systems Engineering is a discipline necessary for cost-effective development of complex multi-disciplinary systems. Optimal design of modern systems for defense, transportation, telecommunications and energy, among other industries, requires a different perspective than the design of subsystems operating within them. This course presents principles and the practice of Systems Engineering, along with its origins in the aerospace and software industries, historical perspective and case studies of current interest. Topics include system life-cycle, requirements definition, modeling, personality, trade studies, design optimization (with minimal information), risk management, proposal writing and others. Guest lecturers and case studies provide a realistic setting for understanding the application of course materials. Prereq: Engineering Standing.

***ME 526 LEAN OPERATIONS MANAGEMENT. (3)**

This course will cover topics in basic lean system operations as well as the management system to support the attainment of highest customer satisfaction with respect to Safety, Quality, Cost, Productivity, Delivery and Human Resource Development. Working in teams, students apply fundamental lean tools and concepts to develop a lean operations environment capable of driving continuous improvement in a simulated factory. As the operational environment evolves, key management principles and tools are explored using the teachings of Taiichi Ohno and others considered to be the pillars of the Toyota Production System. All students must have a webcam and microphone or headset to participate in on-line team and class meetings. Prereq: Enrollment restricted to junior-level or above students. Prior enrollment in the Lean Student certificate course or MFS 503 is required or with the consent of the instructor. (Same as EE 526/MFS 526.)

ME 527 APPLIED MATHEMATICS IN THE NATURAL SCIENCES I. (3)

Construction, analysis and interpretation of mathematical models applied to problems in the natural sciences. Physical problems whose solutions involve special topics in applied mathematics are formulated, various solution techniques are introduced, and the mathematical results are interpreted. Fourier analysis, dimensional analysis and scaling rules, regular and singular perturbation theory, random processes and diffusion are samples of selected topics studied in the applications. Intended for students in applied mathematics, science and engineering. Prereq: MA 432G or three hours in an equivalent junior/senior level mathematics course, or consent of instructor. This course is open only to graduate students or undergraduates with engineering standing. (Same as MA 527.)

ME 530 GAS DYNAMICS. (3)

Consideration of the mass, energy and force balances applied to compressible fluids. Isentropic flow, diabatic flow, flow with friction, wave phenomena and one-dimensional gas dynamics. Applications to duct flows and to jet and rocket propulsion engines. Prereq: ME 321, ME 330 and Engineering standing.

ME 531 FLUID DYNAMICS I. (3)

Stress at a point (introduced as a tensor of rank two). Equation of conservation of mass, rate of strain tensor, derivation of Navier-Stokes equation, source-sink flows, motion due to a doublet, vortex flow, two- and three-dimensional irrotational flow due to a moving cylinder with circulation, two-dimensional airfoils. Prereq: ME 330, MA 432G and Engineering standing.

ME 532 ADVANCED STRENGTH OF MATERIALS. (3)

Unsymmetrical bending of beams, thin plates, stress analysis of thick-walled cylinders, and rotating discs. Theory of elastic energy, curved beams, stress concentration, and fatigue. Prereq: EM 302 and engineering standing. (Same as EM 531.)

ME 548 AERODYNAMICS OF TURBOMACHINERY. (3)

Aerodynamic analysis and design of turbomachines (pumps, compressors and turbines). Blade element performance (deflection and losses), and models for performance prediction are present. Special topics - rotating stall and surge, and aeromechanical considerations. Prereq: ME 321 and ME 330. This course is open only to graduate students or undergraduates with engineering standing.

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ME 549 POWER GENERATION. (3)

Modern powerplants for electric power generation and cogeneration. Thermodynamic analysis of different concepts of powerplants. Design studies of specific powerplants. Prereq: ME 321 and ME 330. This course is open only to graduate students or undergraduates with engineering standing.

ME 554 CHEMICAL AND PHYSICAL PROCESSING OF POLYMER SYSTEMS. (3)

Theory and practice as related to the chemical and physical processing of polymer systems. Polymer rheology, heat transfer in polymer flows, polymer engineering properties. Polymer processing operations and materials selection; flow instabilities. Prereq: CME 330, CME 425 or ME 325; or consent of instructor. This course is open only to graduate students or undergraduates with engineering standing. (Same as CME/MFS/MSE 554.)

ME 555 INTRODUCTION TO MICRO-/NANO-ELECTROMECHANICAL SYSTEMS. (3)

This course provides an overview of micromachined structures with an emphasis on operational theory and fabrication technology. Prereq: Engineering standing or consent of instructor. (Same as EE/MSE 555.)

ME 556 INTRODUCTION TO COMPOSITE MATERIALS. (3)

Modern composite materials and their applications. Basic concepts and definitions. Fundamental properties of fibers and polymer resins. Manufacturing methods. Analysis and design of laminated and chopped fiber reinforced composites. Micro- and macro-mechanical analysis of elastic constants. Failure theory of composite materials. Computational design of composites. Prereq: Engineering Standing, and EM 302 or with instructor permission. (Same as CME/MFS/MSE 556.)

ME 560 ENGINEERING OPTICS. (3)

Fundamentals of geometrical and physical optics; applications as related to problems in engineering design and research, details of some optical measurement techniques; introduction to lasers; techniques for determining optical properties. Prereq: Engineering standing. (Same as EE 566.)

ME 563 BASIC COMBUSTION PHENOMENA. (3)

Simultaneous application of fluid mechanics, heat and mass transfer, chemical kinetics and thermodynamics to combustion. Topics covered include chemical kinetics, chain and thermal explosions, detonation and deflagration, flammability limits, stirred reactors. Flame stabilization in high and low velocity streams, laminar and turbulent diffusion flames, droplet burning, and metal combustion. Prereq: ME 321, ME 330, ME 325 and engineering standing; or graduate standing.

ME 565 SCALE MODELING IN ENGINEERING. (3)

A study of concepts of scale modeling in engineering applications. The course will include dimensionless numbers, scaling laws, and their application in engineering design and research. Prereq: ME 310, ME 321, ME 325. This course is open only to graduate students or undergraduates with engineering standing.

ME 570 FUNDAMENTALS OF NANOELECTRONIC DEVICES AND MATERIALS. (3)

Energy bands in crystals; heterostructures; quantum wells and low dimensional systems; the two-dimensional electron gas and MODFET; transmission in nanostructures; current topics in nanoscale devices. Prereq: ME 310, ME 321, ME 325. This course is open only to graduate students or undergraduates with engineering standing. (Same as EE/MSE 570.)

ME 580 HEATING, VENTILATING AND AIR CONDITIONING. (3)

A course emphasizing the use of thermodynamics, fluid mechanics, and heat transfer principles in thermal environmental design. Building energy requirements will be computed and thermal comfort criteria will be studied. Prereq: BAE 427 or ME 321, or consent of instructor. This course is open only to graduate students or undergraduates with engineering standing. (Same as BAE 580.)

ME 585 FOURIER SERIES AND BOUNDARY VALUE PROBLEMS. (3)

An introductory treatment of Fourier series and its application to the solution of boundary value problems in the partial differential equations of physics and engineering. Orthogonal sets of functions, Fourier series and integrals, solution of boundary value problems, theory and application of Bessel functions and Legendre polynomials. Prereq: MA 432G or equivalent. This course is open only to graduate students or undergraduates with engineering standing. (Same as MA 485G.)

ME 599 TOPICS IN MECHANICAL ENGINEERING (Subtitle required). (3)

A detailed investigation of a topic of current significance in mechanical engineering such as: computer-aided manufacturing, special topics in robotics, and current topics in heat transfer. May be repeated under different subtitles to a maximum of nine credits. A particular topic may be offered at most twice under the ME 599 number. Prereq: Variable; given when topic is identified. This course is open only to graduate students or undergraduates with engineering standing.

PREREQUISITE FOR GRADUATE WORK: Students desiring to take any of the following courses should have a thorough working knowledge of chemistry, physics and mathematics.

#ME 601 INTRODUCTION TO FINITE ELEMENT ANALYSIS. (3)

Theoretical, conceptual, and computational aspects of the finite element method are developed. Development of the element relationships, element calculations, and assembly of the finite element equations are covered. Both one- and two-dimensional finite element problems are considered. One-dimensional problem areas include elastic deformation, heat conduction, fluid flow, electrostatics, groundwater flow, mass transport, beams on elastic foundations, etc. Two-dimensional problem areas include Poisson's equation, viscous incompressible flow, plane elasticity, and bending of elastic plates. Prereq: MA 432G, MA 537 or consent of instructor. (Same as CE 621.)

ME 602 DYNAMICS OF DISTRIBUTED MECHANICAL SYSTEMS. (3)

Applications of small-oscillation shell theory to continuous mechanical systems modeled by shells, plates, rings, arches, membranes, beams, etc. Study of natural frequencies, modeshapes, forced-vibration characteristics, system dampings, dynamic influence function, combination of subsystems, active and passive vibration controls and dampings. Prereq: ME 540 or EM 513, or consent of instructor.

ME 603 MECHANICS OF PLASTIC SOLIDS I. (3)

Permanent changes in shape of solid materials occur as plastic deformations in many engineering applications, such as extrusion, forging and rolling. This course examines the experimental basis and fundamental theoretical framework for plastic materials. The analysis of plastic deformations in simple bending, torsion, tension and compression, and some two dimensional problems are presented. Connection between mechanics parameters, design variables and metallurgical phenomena are discussed. Limit analysis is studied. Prereq: EM 601/ME 641, or EM/ME 651 or consent of instructor.

ME 605 MODELING, SIMULATION AND CONTROL FOR MANUFACTURING. (3)

The purpose of this course is to examine methods and systems from the perspectives of modeling, simulation, and control of manufacturing facilities. The emphasis will be primarily on techniques that can be used to model and evaluate performance of systems. Students are encouraged to think critically about available technologies, identify relative strengths and weaknesses, and analyze the technologies toward developing improved solutions to factory control and information management problems. Prereq: Graduate Standing. (Same as EE/MFS 605.)

ME 606 GLOBAL ISSUES IN MANUFACTURING. (3)

The need to increase quality, productivity, efficiency and sustainability in manufacturing operations spanning the product, process and systems (manufacturing systems as well as supply chain) domains is essential for companies to be successful. The increased globalization of markets and manufacturing operations, declining natural resources and negative consequences of some manufacturing practices as well as increased legislation in many regions has led to many new challenges that companies must overcome to be successful in competitive markets. This seminar course will introduce students to a variety of global issues in manufacturing through presentations by leading national and international experts in these domains. The seminars will cover a broad range of manufacturing related topics relevant to many disciplines including manufacturing, mechanical and electrical engineering. The course can also help graduate students identify topical issues that need further investigation and could become potential research topics. (Same as EE/MFS 606.)

ME 607 ANALYSIS OF METAL CUTTING PROCESSES. (3)

Advanced study of metal cutting involving the mechanics of metal cutting including cutting forces, tool-wear/tool-life and temperature analysis, surface finish and integrity, chip control, machinability assessments and advances in cutting tool technology. Prereq: ME 505. (Same as MFS/MSE 607).

ME 610 ENGINEERING ACOUSTICS. (3)

A comprehensive study of wave propagation in fluids; derivation of the scalar wave equation and a study of its elementary solutions for time harmonic and transient waves in one, two and three dimensions. Radiation and scattering of waves at fluid and solid boundaries. Integral equation solution of the scalar velocity wave potential; numerical methods. Prereq or concur: MA 432G.

ME 611 BOUNDARY ELEMENT METHODS IN ENGINEERING. (3)

Introduction of boundary element methods for use in solving common engineering equations, such as the Laplace equation, the Poisson equation, the wave equation, and the diffusion equation. Both the theoretical and numerical aspects of the boundary element technique are presented. Application areas include heat conduction, potential flow problems, acoustic wave propagation, general diffusion, and stress analysis. Prereq: EGR 537 or consent of instructor. (Same as EGR 611.)

ME 613 NONLINEAR OSCILLATIONS. (3)

Many physical systems exhibit some nonlinear behavior. This course presents some methods of analyzing discrete, nonlinear, dynamical systems and applies the methods to typical mechanical systems. Various kinds of nonlinear behavior, including resonance phenomena such as harmonics, parametric excitation, and discontinuous jumps in amplitude are considered. Lyapunov stability criteria and Floquet and Routhian procedures for performing stability analyses of systems are introduced, and their physical interpretations for various systems are studied. Prereq: EM/ME 513.

ME 620 ADVANCED ENGINEERING THERMODYNAMICS I. (3)

Critical treatment of the laws of thermodynamics, relations among thermodynamic properties; stability of systems; thermodynamic processes; selected special topics. Prereq: ME 321.

ME 626 ADVANCED HEAT CONVECTION. (3)

Comprehensive study of heat convection; derivation of equations of convection of mass, momentum, and energy; boundary layer equations; classical solutions of laminar convection problems; turbulent convection; analogies between momentum and energy. Prereq: ME 325, MA 432G or concurrent.

ME 627 RADIATION HEAT TRANSFER. (3)

Principles of thermal radiation, the determination of radiation properties, and the analysis of radiation heat transfer. Results of recent radiation researches are included in the discussions. Prereq: ME 325, MA 432G or concurrent.

ME 628 BOILING AND CONDENSATION. (3)

Phase-change heat transfer including boiling and condensation. Phenomenological treatment of boiling using hydrodynamic instability. Theory of two-phase flow and its application to forced flow boiling. Film and dropwise condensation. Prereq: ME 325.

ME 631 FLUID DYNAMICS II. (3)

A continuation of ME 531 with emphasis on viscous flow. Exact and approximate solutions, boundary layer theory. Jets, wakes, rotating systems, compressible boundary layer and hydrodynamic stability. Prereq: ME 531 or consent of instructor.

ME 634 TURBULENT FLOWS. (3)

Physical and analytical description of turbulent flows, isotropic turbulence, boundary layers and shear flows, free turbulence in jets and wakes. Measurement techniques. Prereq: ME 531; prereq or concur: ME 631.

ME 641 FOUNDATIONS OF SOLID MECHANICS. (3)

A brief review of vectors and an in-depth discussion of tensors and tensor calculus. Stress, deformation and strain. Continuum balance principles of mass, momentum and energy, the equations of motion and the energy equation. Entropy, the principles of material frame indifference and material symmetry. Various constitutive models, including elasticity (linear and/or non-linear), plasticity and viscoelasticity. Thermoelasticity, hyperelasticity, hypoelasticity, and electroelasticity may also be addressed. Prereq: EM 531 or ME 532 or consent of instructor.

ME 644 ADVANCED DYNAMICS I. (3)

Many physical systems in engineering involve rigid bodies in translation and rotation. Such motions are studied in this course by the use of Euler's Laws. The kinematical description of the motions utilize the concept of reference frames. The inertia properties of rigid bodies, and the energy functions for rigid bodies are covered. Analytical and numerical solutions of dynamical systems of engineering interest are considered. Prereq: EM 313; prereq, or concur: MA 432G.

ME 645 ADVANCED CONTROL SYSTEM ANALYSIS. (3)

Conceptual development and study of complex systems; their synthesis and design; analysis and optimization of system parameters. Input-output relationships; formulation of mathematical models, parameters and constraints on physical systems. Prereq: ME 440 or instructor consent. (Same as EE 645.)

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ME 647 SYSTEM OPTIMIZATION I. (3)

Introduction to linear and nonlinear optimization and their use in engineering design. Emphasis on numerical approaches and use of optimization methods for engineering systems (e.g. biological, mechanical, structural). Prereq: CS 221 or equivalent; one mathematics course beyond MA 214 or equivalent. (Same as BAE 647.)

ME 651 MECHANICS OF ELASTIC SOLIDS I. (3)

Many engineering applications involve the use of materials that behave elastically when performing their designed function. This course concerns the general analysis of small deformations, stress, and stress-deformation relations for elastic bodies. The solution of typical problems frequently encountered in engineering applications, e.g., extension, bending, and torsion of elastic bars, stress concentrations and thermoelastic behavior, are studied. Some modern computational methods currently used in engineering practice are introduced. Prereq: MA 432G or consent of instructor.

ME 652 MECHANICS OF ELASTIC SOLIDS II. (3)

Continuation of EM 651 with more attention to the fundamental structure of and important historical and contemporary contributions to elastic theory. Extensive use of modern computational methods that were introduced in the first course will provide familiarity with the solution of larger scale, industrially important elasticity problems. Application of the boundary integral equation method (BIE) will be emphasized. Some use also will be made of the finite element method, primarily for comparison with BIE. Instruction will include “hands-on” experience with digital-computer program packages. Prereq: EM 651 or consent of instructor.

ME 672 NONLINEAR SYSTEMS AND CONTROL. (3)

This course presents methods for analyzing and controlling nonlinear dynamic systems. The major topics are: 1) fundamental properties of nonlinear ordinary differential equations such as existence and uniqueness; 2) Lyapunov stability theory; and 3) nonlinear feedback control techniques such as backstepping, feedback linearization, and Lyapunov-based design. (Same as EE 672.)

ME 690 ADVANCED ALGORITHMS FOR COMPUTATIONAL FLUID DYNAMICS. (4)

Theory and implementation of main algorithms widely used for solving multi-dimensional partial differential equations arising in engineering applications such as fluid dynamics, heat and mass transfer, semiconductor simulation, etc. Numerical solution of steady and time-dependent linear partial differential equations on rectangular domains via finite difference techniques. Linearization methods for treatment of nonlinear problems. Numerical grid generation for transforming irregular domains into rectangular computational grids. Prereq: MA 537, or consent of instructor, and competence with a high-level programming language.

ME 691 CFD I - INCOMPRESSIBLE FLOWS. (3)

This course will cover a control-volume CFD approach for the conservation of momentum, heat and mass transfer. The emphasis will be on the discretization of the transport equations in general coordinates and its application in both structured and unstructured grid arrangements. Modern numerical schemes and pressure solution algorithms will also be covered. An introduction of turbulence modeling will be provided. At the end of the lecture, the students not only are able to understand the basics of commercial software but also will be able to write a general coordinate code for fluid flow, heat and mass transfer applications. Prereq: ME 531.

ME 692 CFD II - COMPRESSIBLE FLOWS. (3)

This second course shall focus on the solution of the compressible Navier-Stokes equations. The Van-Leer's and Roe's approaches will be discussed to derive the discretization equations. Modern shock capturing schemes, such as FCT, TVD and ENO will be introduced. The solution techniques such as ADI, DDADI and line-relaxation will be used to solve the system of equations. Multi-grid acceleration techniques will be introduced to speed up the rate of convergence. Finally, the parallelization of CFD codes using shared and distributed computers will be discussed. Prereq: ME 531 and ME 691.

ME 699 TOPICS IN MECHANICAL ENGINEERING (Subtitle required). (3)

A detailed investigation of a topic of current significance in mechanical engineering. May be repeated to a maximum of nine credits under different subtitles. A particular topic may be offered at most twice under the ME 699 number. Prereq: Variable; given when topic is identified.

ME 748 MASTER'S THESIS RESEARCH. (0)

Half-time to full-time work on thesis. May be repeated to a maximum of six semesters. Prereq: All course work toward the degree must be completed.

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- ME 749 DISSERTATION RESEARCH. (0)**
Half-time to full-time work on dissertation. May be repeated to a maximum of six semesters. Prereq: Registration for two full-time semesters of 769 residence credit following the successful completion of the qualifying exams.
- ME 767 DISSERTATION RESIDENCY CREDIT. (2)**
Residency credit for dissertation research after the qualifying examination. Students may register for this course in the semester of the qualifying examination. A minimum of two semesters are required as well as continuous enrollment (Fall and Spring) until the dissertation is completed and defended.
- ME 768 RESIDENCE CREDIT FOR MASTER'S DEGREE. (1-6)**
May be repeated to a maximum of 12 hours.
- ME 769 RESIDENCE CREDIT FOR DOCTOR'S DEGREE. (0-12)**
May be repeated indefinitely.
- ME 780 SPECIAL PROBLEMS IN MECHANICAL ENGINEERING. (3)**
This course consists of individual work in one of the various fields of mechanical engineering. May be repeated three times for a maximum of 12 credits. Prereq: Approval of instructor.
- ME 790 RESEARCH IN MECHANICAL ENGINEERING. (1-9)**
Work may be taken in any field of mechanical engineering, subject to the approval of the director of graduate studies. May be used to satisfy pre-qualifying examination residency credit. May be repeated to a maximum of 18 hours.
- ME 799 MECHANICAL ENGINEERING GRADUATE SEMINAR. (0)**
A series of talks presented by national and local speakers that will provide graduate students with an overview of current research activities in the broad field of Mechanical Engineering. Prereq: Engineering Graduate student standing or consent of instructor.