MECHANICAL ENGINEERING

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Chairperson: Nabil G. Chalhoub
Director ME Graduate Studies: Ming-Chia Lai
http://engineering.wayne.edu/me/

The opportunities and challenges in the field of mechanical engineering are diverse and virtually unlimited. The broad variety of career possibilities includes research and development, design analysis and synthesis, manufacturing and production engineering, testing, sales, engineering, maintenance and administration. The challenge of a mechanical engineer may lie in the perfection and reliability of a device that will be duplicated a million-fold or in the control optimization of a single complex system of unique design. The mechanical engineering curriculum is designed to prepare graduate students in many applied fields, including such important areas as biomechanics, energy conversion, combustion engines, emissions controls, machine tool design, manufacturing, computer graphics, structural analysis, automatic controls, vehicle dynamics and design, continuum mechanics, fluid dynamics, environmental design, mechanisms, acoustics and noise control, laser diagnostics, and composite materials. Faculty members in the Department are currently engaged in state-of-the-art research in all of these areas. Specialized areas of research support for graduate students include: manufacturing processes, composite material behavior, combustion, acoustics and noise control, vibrations, laser diagnostics, biomechanics, control of mechanical systems, sheet metal stamping, and engine research.

Part-time study (with most courses offered in the evening) and cooperative programs allow professionals working in local industry to pursue graduate degrees while employed.

ABIANEH, OMID SAMIMI: Ph.D. and M.S., University of Alabama-Huntsville; Assistant Professor

ARAVA, LEELA: Ph.D., Indian Institute of Technology Madras, India; M.S., B.S., Sri Venkateswara University, India ; Assistant Professor

AYORINDE, EMMANUEL: Ph.D., M.S., B.S., University of Nottingham; Associate Professor

BERDICHEVSKY, VICTOR L.: Ph.D., M.S.c, Moscow State University; Professor

BRYZIK, WALTER: Ph.D., M.S., B.S., University of Detroit; Professor Emeritus

CHALHOUB, NABIL: Ph.D., University of Michigan; M.S., B.S., Wayne State University; Professor and Chair

DINDA, GURU PRASAD: Ph.D., Saarland University; M.Tech., Indian Institute of Technology; B.E., National Institute of Technology; Assistant Professor

EAGLE, W. ETHAN: Ph.D., University of Michigan; M.S. and B.S., University of Maryland; Assistant Professor

GIBSON, RONALD: Ph.D., University of Minnesota; M.S., University of Tennessee; B.S., University of Florida; Professor Emeritus

HENEIN, NAEIM A.: Ph.D., University of Michigan; M.S., Alexandria University; B.S., Cairo University; Distinguished Professor

IBRAHIM, RAOUF A.: Ph.D., University of Edinburgh; M.S., B.S., University of Cairo; Professor Emeritus

JANSONS, MARCIS: Ph.D., B.S., Rutgers University; M.S., New Jersey Institute of Technology; Associate Professor

KLINE, K.A.: Ph.D., B.S., University of Minnesota; Professor Emeritus

KU, JERRY C.: Ph.D., M.S., State University of New York at Buffalo; B.S., Tatung Institute of Technology; Associate Professor

LAI, MING-CHIA: Ph.D., M.S., Pennsylvania State University; Professor

NEWAZ, GOLAM M.: Ph.D., M.S., University of Illinois at Urbana-Champaign; B.S., Texas A & M University; Professor

OZBEKI, Mohammad Ali E.: Ph.D., Penn State University; M.B.A., University of Detroit Mercy; M.S., University of Michigan; Lecturer

PYLYPCHUK, VALERY: Dr. Sci., Moscow Institute for Problems in Mechanics, Russian Academy of Sciences; Lecturer

SINGH, TRILOCHAN: Ph.D., M.S., University of California; B.S., Punjabi University; Professor Emeritus

TAN, CHIN-AN: Ph.D., B.S., Univesity of California - Berkeley; M.S., California Institute of Technology; Professor

TARAZA, DINU: Ph.D., B.S., Polytechnic Institute of Bucharest; Professor Emeritus

WU, SEAN-FENG: Ph.D., M.S.M.E., Georgia Institute of Technology; Distinguished Professor

WU, XIN: Ph.D., M.S., University of Michigan; Associate Professor

- Mechanical Engineering (M.S.) (http://bulletins.wayne.edu/graduate/college-engineering/mechanical-engineering/mechanical-engineering-ms)
- Mechanical Engineering (Ph.D.) (http://bulletins.wayne.edu/graduate/college-engineering/mechanical-engineering/mechanical-engineering-phd)

ME 5000 Engineering Analysis I Cr. 4
Applications of ordinary differential equations. The method of Frobenius, Bessel functions, Legendre polynomials. Orthogonality of characteristic functions. Fourier series and Fourier integrals. Characteristics and solutions of partial differential equations. Method of separation or variations. Applications to initial and boundary value problems in engineering. Offered Fall.
Course Material Fees: $5

ME 5040 Finite Element Methods I Cr. 4
Introduce finite element methods and review solid mechanics concepts and formalisms, variational methods and potential energy principles. Emphasize the basic understanding of the finite element method including its physical and mathematical principles, numerical procedures and their implementation. Define displacement-based formulations of spring, bar, beam, plane strain and plane stress elements along with isoparametric element formulation, assembly of elements and solution of global stiffness equations. Offered Fall, Winter.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 5100 Quantitative Physiology Cr. 4
Basic principles of human physiology presented from the engineering perspective. Bodily functions, their regulation and control discussed in quantitative terms and illustrated by mathematical models where feasible. Offered Fall, Winter.
Equivalent: BME 5010, CHE 5100, ECE 5100

ME 5110 Fundamental Fuel Cell Systems Cr. 4
Introduce various types of fuel cells, materials properties of electrodes and polymeric membranes, and electrochemical mechanisms. Reforming of various types of hydrocarbon fuel to hydrogen, and reforming technology. Offered Fall.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.
Equivalent: AET 5110, CHE 5110, EVE 5130

ME 5115 Fundamentals of Electric-drive Vehicle Engineering Cr. 4
Cover engineering fundamentals and basic design of electric-drive vehicle powertrains by understanding and analyzing the relevant multi-physics and applying the associated equations and simple models. Offered Fall.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.
Equivalent: EVE 5110

ME 5120 Fundamentals of Alternative Energy Technology Cr. 4
Provide an overview/review of thermodynamics. Cover advanced thermodynamics topics of energy and chemical reacting systems. Introduce general areas of alternative energy technology, engineering analysis and design of solar angle/time/radiation, solar heating, solar photovoltaic, and wind power. Offered Winter.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.
Equivalent: AET 5120

ME 5160 Musculoskeletal Biomechanics Cr. 4
Structure and properties of the major tissue components of the musculoskeletal system and evaluation of how tissues combine to provide support and motion to the body. Offered Fall.
Prerequisite: BME 5010 with a minimum grade of C or BMS 6550 with a minimum grade of C
Equivalent: BME 5210

ME 5170 Design of Human Rehabilitation Systems Cr. 4
Design, fabrication and testing of customized hardware to aid handicapped patients. Offered Fall.

ME 5180 Introduction to Biomaterials Cr. 4
Introduction to study of both biological materials (bone, muscle, etc.) and materials for medical applications. Topics include tissue properties and effects of pathology, biocompatibility, and design considerations. Offered Winter.
Prerequisites: BE 1300 with a minimum grade of C- and BME 5010 with a minimum grade of C- or BMS 6550 with a minimum grade of C
Equivalent: BME 5370

ME 5210 Convective and Radiative Heat Transfer Cr. 4
Introduce radiative processes, properties of solids, radiative heat transfer among surfaces in an enclosure and gas radiation. Derive energy equation for laminar flows. Apply semi-empirical correlations for forced and free convection of laminar and turbulent flows. Implement analytical methods for convective heat transfer and heat exchange analysis. Offered Fall.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 5215 Fundamentals of Battery Systems for Electric and Hybrid Vehicles Cr. 4
Covers fundamental electrochemistry and engineering aspects for electric propulsion batteries including lead acid, nickel metal hydride, lithium ion and capacitor technologies. Offered Winter.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.
Equivalent: AET 5310, CHE 5120, EVE 5120

ME 5300 Intermediate Fluid Mechanics Cr. 4
Introduce fluid kinematics entailing vector field, potential flows, vorticity along with the computation of particle trajectory in a given velocity field and near stagnation points. Define basics of fluid dynamics including stress tensor in fluids, Navier-Stokes equations, Euler's equations, properties of solutions of Euler's equations, Bernoulli's integral and role of viscosity. Extend the analysis to two-dimensional potential flows and vortex flows. Offered Winter.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 5330 Advanced Thermal Fluid System Design Cr. 4
Involve teamwork on semester-long open-ended design project of thermal fluid systems to meet performance requirements using sound design process and system engineering approach. Apply engineering principles and computational design software to analyze and optimize system or subsystem processes. Offered Fall, Winter.
Prerequisites: ENG 3060 with a minimum grade of C- and ME 4210 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the College of Engineering.
Course Material Fees: $40

ME 5400 Dynamics II Cr. 4
Cover three-dimensional kinematics and kinetics of rigid bodies, Euler angles, angular momentum, D'Alembert Principle, equations of motion in general rotating coordinate frames. Derive Lagrange's equation of motion for particles and rigid bodies. Introduce Lagrange multipliers, holonomic and non-holonomic constraints, virtual work principle, and Hamilton's Principle. Offered Fall.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.
Course Material Fees: $10

ME 5410 Vibrations II Cr. 4
Review the vibration response of two-degree-of-freedom systems including frequency response function. Extend the analysis to multi-degree-of-freedom systems including eigenvalues (natural frequencies) and orthogonality of eigenvectors (normal modes). Introduce numerical and experimental modal analysis techniques. Formulate the boundary-value problem for the vibration of continuous structural elements such as rods, strings, and beams. Offered Winter.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 5425 Analysis of Vibration Movements and Instrumentation Cr. 4
Basic tools and instrumentation, such as spectral analyzers to measure and analyze vibration time histories of excitation and response signals (stationary or non-stationary) in the time and frequency domains. Fast Fourier transform, frequency time analyses. Offered Fall.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.
Course Material Fees: $20

ME 5440 Industrial Noise Control Cr. 4
Basic and advanced measurement techniques to acquire various acoustic quantities in a non-ideal environment including measurements of pressure, power and intensity of sound levels, reverberation time, absorption, coefficients of materials, room acoustics, and modal analysis. Cover noise reduction and control strategies for engineering applications. Offered Fall.
Restriction(s): Enrollment limited to students in the College of Engineering.

ME 5453 Automotive Manufacturing Systems and Processes Cr. 4
Introduce principles and methodologies of automotive assembly systems and processes. Cover operation management, quality management, principle of system development, planning and analysis of assembly systems and supportive functions, assembly processes, automatic and manual operations, management of tooling development and honing processes of sheet metal parts. Offered Spring/Summer.
Prerequisite: ME 3450 with a minimum grade of C- or ME 4250 with a minimum grade of C-
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 5460 Fundamentals in Acoustics and Noise Control Cr. 4
Introduce principles of sound generation, propagation and interaction with solid boundary surfaces, as well as engineering noise control applications. Gain hands-on experience on simulating sound radiation and interactions with solid boundaries, and estimating sound transmission through partitions. Offered Every Other Fall.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 5465 Lasers for Medical Applications Cr. 3
Summarizes the wealth of recent research on the principles, technologies and application of lasers in diagnostics, therapy and surgery. Includes an overview of optics, optical components used in a typical laser, key principles of lasers and radiation interactions with tissue. The respective types of the laser (solid state, gas, dye, and semiconductor) are reviewed to provide an understanding of the wide diversity, and therefore, the large possible choice of these devices for a specific diagnosis, treatment, or surgery. Offered Winter.
Equivalent: BME 5460, PHY 5460

ME 5500 Advanced Engineering Design Cr. 4
Satisfies General Education Requirement: Writing Intensive Competency
Involve teamwork on semester-long open-ended design project. Develop design concepts based on various design theories, analyze alternative solutions and identify "best design solution" within given constraints. Students perform patent literature search, design, fabricate, develop and test prototypes. Perform product verification and validation. Require submission of formal progress reports, a final written report and a public presentation. Course satisfies Writing Intensive course requirement. Offered Fall, Winter.
Prerequisites: BE 2550 with a minimum grade of C-, ENG 3060 with a minimum grade of C-, and ME 4250 with a minimum grade of C-
Course Material Fees: $50

ME 5580 Computer-Aided Mechanical Design Cr. 4
Introduce aspects of constraint-based solid modeling and parametric modeling using Unigraphics, Solid Edge, I-DEAS and Pro-E. Develop intelligent solid models with application to data management and sheet metal design. Introduce computer-aided simulation and manufacturing. Offered Spring/Summer.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 5620 Fracture Mechanics in Engineering Design Cr. 4
Introduce linear and nonlinear fracture mechanics principles and their applications to structural design. Formulate fracture parameters based on energy methods and stress-intensity factors for linear elastic fracture mechanics (LEFM), J-Integral and crack tip opening displacement (CTOD) for elastic plastic fracture mechanics (EPFM). Introduce design concepts based on failure assessment diagram and damage tolerance. Cover crack growth mechanisms, crack closure and crack retardation concepts. Offered Fall, Winter.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 5700 Fundamentals of Mechanics Cr. 4
Introduce Lagrangian and Hamiltonian classical mechanics. Derive thermodynamics laws from mechanics. Cover continuum kinematics and basics of tensor analysis, continuum mechanics (basic laws; thermodynamics of continuum media; classical continuum models). Offered Winter.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.
Course Material Fees: $5

ME 5720 Mechanics of Composite Materials Cr. 4
Develop a comprehensive understanding of analytical models of micro-mechanical and macro-mechanical behavior of composite materials. Conduct stiffness, strength, hydrothermal, laminate, viscoelastic, dynamic behavior and fracture analyses. Introduce experimental characterization procedures for mechanical behavior evaluation. Offered Fall.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 5730 Tribology and Lubrication Technology Cr. 4
Introduce friction, wear, and lubrication fundamentals including wear mechanisms, application of coatings, surface engineering fundamentals, measurement of surface topological features and surface wear. Offered Yearly.

ME 5780 Products Liability Introduction for Engineers Cr. 1
Application of engineering practice to minimize products liability exposure. Stages of a products liability lawsuit; how engineers may be involved at different stages of the process. Offered Yearly.
Restriction(s): Enrollment limited to students with a class of Applicant Masters, Candidate Masters or Senior; enrollment limited to students in the College of Engineering.
Equivalent: IE 5780

ME 5800 Combustion Engines Cr. 4
Cover thermodynamics and cycle analysis of spark and compression ignition engines. Introduce combustion processes in actual systems, engine performance characteristics and engine modeling. Offered Fall, Winter.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 5810 Combustion and Emissions Cr. 4
Define air quality and emissions standards. Cover fundamentals of emission formation in combustion systems, wall quenching and imperfect combustion, unburned hydrocarbons, carbon monoxide, aldehydes, nitrogen oxides, species stratification in the combustion chamber, and particulates. Discuss the effects of design parameters and engine operating variables on emission formation. Introduce chemical kinetics simulation. Offered Winter.
Prerequisite: ME 5800 with a minimum grade of C-
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 5820 Thermal Environmental Engineering Cr. 4
Design and analyze heating, ventilating and air-conditioning systems. Introduce moist air properties calculations, heat transfer and transmission coefficients, heating load, cooling load, heating and cooling equipment, duct design, fans, air distribution, and refrigeration principles. Offered Spring/Summer.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 5900 National Design Competition Projects Cr. 1-4
Offered Every Term.
Repeatable for 998.99 Credits

ME 5990 Directed Study Cr. 1-4
Offered Every Term.
Repeatable for 6 Credits

ME 5992 Research Experiences for Undergraduates Cr. 1-4
Offered for undergraduate credit only. Offered Intermittently.
Restriction(s): Enrollment is limited to Undergraduate level students.
Repeatable for 6 Credits

ME 5995 Special Topics in Mechanical Engineering I Cr. 1-4
Topics to be announced in Schedule of Classes . Offered Intermittently.
Restriction(s): Enrollment limited to students in the College of Engineering.
Repeatable for 8 Credits

ME 6180 Biomedical Instrumentation Cr. 4
Engineering principles of physiological measurements, signal conditioning equipment, amplifiers, recorders and transducers. Recent advances in instrumentation. Offered Winter.
Prerequisites: BME 5020 with a minimum grade of C and ECE 3300 with a minimum grade of C or BME 5010 with a minimum grade of C or BMS 6550 with a minimum grade of C
Equivalent: BME 6480, ECE 6180

ME 6550 Modeling and Control of Dynamic Systems Cr. 4
Introduce state-space representation of dynamical systems, apply Lyapunov stability criteria, and examine controllability and observability of systems. Design linear state feedback controllers using pole-placement technique and formulate full- and reduced-order linear state observers such as Luenberger observer. Design linear model following controller and linear quadratic optimal controllers. Offered Fall.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.
Course Material Fees: $5

ME 6991 Internship in Industry Cr. 1-4
Written report describing internship experience. Offered Every Term.
Repeatable for 4 Credits

ME 7020 Finite Element Methods II Cr. 4
Introduce isoparametric elements, plate and shell elements. Perform dynamic analysis of structures (explicit versus implicit methods). Formulate problems with geometric, materials, and/or contact nonlinearities. Introduce hybrid variational techniques, Cover examples dealing with solids, fluids and heat transfer by utilizing commercially available software such as HyperMesh, OptiStruct, LS/DYNA and ANSYS. Offered Winter.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 7100 Mathematical Modeling in Impact Biomechanics Cr. 4
Review of models created for impact simulations. Regional impact simulation models. Human and dummy models subject to various restraint systems. Offered Winter.
Prerequisite: BME 5010 with a minimum grade of B-
Restriction(s): Enrollment is limited to Graduate level students.
Equivalent: BME 7100, ECE 7100, IE 7100

ME 7160 Impact Biomechanics Cr. 4
Biomechanical response of the body regions and the whole body to impact. Mechanisms of injury in blunt impact. Effects of restraints on injury reduction. Development of test surrogates such as dummies. Offered Fall.
Prerequisite: BME 5010 with a minimum grade of B-
Restriction(s): Enrollment is limited to Graduate level students.
Course Material Fees: $10
Equivalent: BME 7160

ME 7180 Advanced Topics in Biomaterials and Tissue Biomechanics Cr. 4
Seminar format: advanced topics presented to the class; lectures by the instructor and by the participants based on literature reviews. Topics determined by student interest. Offered Every Other Fall.
Prerequisite: BME 5210 with a minimum grade of C or BME 5370 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.
Equivalent: BME 7300, MSE 7180

ME 7260 Heat and Mass Transfer Cr. 4
Introduce transport phenomena and rate equations. Formulate heat and mass transfer problems using lumped, differential and integral formulations. Solve these problems using the method of separation of variables, partial solutions, variation of parameters, superposition, Laplace transformation and Duhamel Integral for problems with time-dependent boundary conditions. Apply these concepts to various thermal and combustion systems. Offered Fall.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 7290 Advanced Combustion and Emissions I Cr. 4
Introduce thermodynamics of chemically reacting mixtures, oxidation mechanisms of hydrocarbon fuels, theories of explosions, structure of pre-mixed hydrocarbon flames, propagation of laminar premixed flames, pre-mixed turbulent flames, kinetics of nitrogen oxides formation, combustion and emissions in spark ignition engines and control strategies. Offered Winter.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.
Course Material Fees: $5

ME 7300 Advanced Fluid Mechanics Cr. 4
Understand the physics of governing equations of conservation of mass, momentum, energy, and other scalar properties in transport processes. Express the numerical aspects of the transport processes in finite volume approach and pressure-based solution algorithm. Introduce physical models of turbulence, multi-phase and reacting flows. Acquire hands-on experience of formulation, meshing, simulation, post-processing and presentation to solve engineering problems. Stress the importance of CFD encountered in real-life engineering applications. Offered Winter.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 7310 Computational Fluid Mechanics and Heat Transfer Cr. 4
Understand the physics of governing equations of conservation of mass, momentum, energy, and other scalar properties in transport processes. Express the numerical aspects of the transport processes in finite volume approach and pressure-based solution algorithm. Introduce physical models of turbulence, multi-phase and reacting flows. Acquire hands-on experience of formulation, meshing, simulation, post-processing and presentation to solve engineering problems. Stress the importance of CFD encountered in real-life engineering applications. Offered Fall.
Prerequisite: ME 5300 with a minimum grade of C-
Restriction(s): Enrollment is limited to Graduate level students.

ME 7315 Electric-drive Vehicle Modeling and Simulation Cr. 4
Cover modeling, simulation and control of electric-drive vehicle powertrain including plant modeling, controls model development, and in-the-loop controls testing. Proficiency in MATLAB/Simulink is required. Offered Winter.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.
Equivalent: EVE 7310

ME 7400 Advanced Dynamics Cr. 4
Introduce physical concepts and formalisms of Newtonian, Lagrangian, and Hamiltonian mechanics. Formulate calculus of variations including Hamiltonian least action principle and Euler-Lagrange equation. Develop the boundary-value problem of continuous elastic structures using Hamilton's principle. Model strongly nonlinear dynamical systems involving impact, non-smooth and discontinuous loads. Offered Winter.
Prerequisite: ME 5400 with a minimum grade of C-
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.
Course Material Fees: $5

ME 7410 Vibrations of Continuous Systems Cr. 4
Model and solve boundary-value problems of vibration for continuous elastic structures using approximate algorithms and computational schemes. Assess the effects of boundary conditions on the eigenvalue problem of geometrically nonlinear elastic structures. Offered Winter.
Prerequisite: ME 5400 with a minimum grade of C- and ME 5410 with a minimum grade of C-
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 7420 Random Vibrations Cr. 4
Introduce statistical parameters of random vibration such as mean, mean square, correlation function, power spectral density, cumulant and moment generating function. Define Brownian motion process, white noise, Markov processes, and Fokker-Planck-Kolmogorov equation. Develop stochastic calculus rules (It  and Stratonovich integrals) and stochastic averaging. Generate random response statistics of single- and two-degree-of-freedom systems. Offered Winter.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 7440 Signal Processing Technologies and Their Applications Cr. 4
Develop advanced signal processing techniques for analyzing transient signals containing discontinuities and sharp spikes with applications to such fields as blind sources separation, de-noising time-domain signals, etc. Acquire hands-on experience with software such as LabVIEW to set up experiments and analyze data. Offered Winter.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 7451 Advanced Manufacturing II: Material Forming Cr. 4
Cover classical theory of plasticity and basic equations, deformation behavior and constitutive equations of materials, deformation mechanisms related to microstructures, mechanical analyses of various forming processes, experimental study on material properties, microstructure evolution and forming mechanics. Offered Every Other Fall.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 7460 Advanced Acoustics and Noise Control Cr. 4
Introduce advanced techniques in near-field acoustical holography for visualizing acoustic fields, analyzing vibro-acoustic correlations and identifying the critical vibration components responsible for acoustic radiation from a vibrating structure. Offered Every Other Winter.
Prerequisite: ME 5460 with a minimum grade of C-
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 7480 Nonlinear Vibration Cr. 4
Categorize nonlinearities in mechanical systems and qualitatively describe their effects on the dynamic response. Introduce the concepts of phase portrait, limit cycles, dynamic characteristics of Duffing and Van der Pol oscillators, parametric vibration and parametric resonance. Outline nonlinear techniques such as harmonic balance, averaging method, and multiple scales methods to analyze nonlinear modal interaction (internal resonance), vibro-impact dynamics and chaotic motion. Offered Fall.
Prerequisite: ME 5410 with a minimum grade of C- and ME 7400 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

ME 7550 Control of Dynamic Systems Cr. 4
Formulate static optimization problems with equality constraints, system identification, parameter optimization using Lyapunov's method. Introduce calculus of variations including dynamic optimization with equality constraints and apply them to formulate linear regulator and tracking problems. Introduce Pontryagin's minimum principle and state inequality constraints. Solve minimum-time problems and minimum control-effort problems. Offered Winter.
Prerequisite: ME 6550 with a minimum grade of C- or ECE 5470 with a minimum grade of C-
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.
Course Material Fees: $5

ME 7590 Nonlinear Control Systems Cr. 4
Provide examples of nonlinear dynamical control systems, perform system analysis using phase-portrait, and examine stability using Lyapunov's direct method and invariant set theorems (local and global stability). Introduce describing function method, feedback linearization technique, internal dynamics, and zero-dynamics. Design nonlinear robust controllers. Offered Fall.
Prerequisite: ME 6550 with a minimum grade of C- or ECE 5470 with a minimum grade of C-
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.
Equivalent: ECE 7420

ME 7610 Theory of Elasticity Cr. 4
Define boundary value problems of linear elasticity. Cover variational principles in linear elasticity along with theory of beams, plates and shells. Introduce homogenized description of composite materials. Offered Fall.
Prerequisite: ME 5700 with a minimum grade of C-
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.
Course Material Fees: $5

ME 7680 Manufacturing Processing Mechanics Cr. 4
Perform finite element analysis (FEA) of non-linear large strain deformation problems using the software ABAQUS. Cover thermal-mechanical coupled deformation problems involving micro-manufacturing of micro-electronic mechanical systems (MEMS), electronic packaging, composite curing, creep-fatigue of micro-system and large plastic deformation in metal forming. Offered Yearly.
Prerequisite: ME 5040 with a minimum grade of C-
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 7720 Advanced Mechanics of Composite Materials Cr. 4
Conduct a review on tensor notation with application to stress strain and constitutive equations. Develop damage tolerance analysis and approaches including durability of composite materials and structures. Conduct extensive literature review and independent focused research on the above topics that encompass advanced models and their applications. Offered Winter.
Prerequisite: ME 5720 with a minimum grade of C-
Restriction(s): Enrollment is limited to Graduate level students.

ME 7820 Engineering Non-Destructive Evaluation (NDE) Methods and Industrial Applications Cr. 4
Cover basic and advanced non-destructive evaluation methods used in industry. Treat in-depth the physics and engineering NDE applications of ultrasonics, vibration, acoustic emission and thermal wave sciences. Cover methodologies of penetrant and eddy current diagnostics. Illustrate NDE concepts through laboratory experiments. Offered Fall.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 7850 Dynamics and Vibration of Automotive Engines Cr. 4
Covers kinematics, dynamics and balance of reciprocating engines, engine mounts and torsional vibrations of powertrains. Offered Yearly.
Prerequisite: ME 5800 with a minimum grade of C-
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

ME 7990 Directed Study Cr. 1-4
Advanced study and instruction in mechanical engineering. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 4 Credits

ME 7995 Special Topics in Mechanical Engineering II Cr. 1-8
Special subject matter in mechanical engineering. Topics to be announced in Schedule of Classes . Offered Intermittently.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 8 Credits

ME 7996 Research Cr. 1-4
Perform experimental and analytic study on a selected topic in mechanical engineering. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 4 Credits

ME 8020 Crashworthiness and Occupant Protection in Transportation Systems I Cr. 4
Introduce crashworthiness and occupant safety facts along with computational environment influences. Review of federal motor vehicle safety regulations. Design strategies for crash load sustainment and disbursement. Review the plasticity theory and its application to modeling and design. Define strategic material selection for crash affected and related regions. Cover modeling, analysis and simulation techniques in restraint systems, energy management, and various barrier crash tests. Offered Fall, Winter.
Prerequisite: ME 5040 with a minimum grade of C-
Restriction(s): Enrollment is limited to Graduate level students.

ME 8030 Crashworthiness and Occupant Protection in Transportation Systems II Cr. 4
Develop mathematical models of vehicle crashes in front, side, rear, and rollover modes. Cover roles of vehicle structures and restraint systems in reducing risk of injury. Offered Winter.
Prerequisite: ME 8020 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

ME 8290 Advanced Combustion and Emissions II Cr. 4
Introduce single-component and multi-component droplet evaporation and combustion processes, liquid fuel sprays formation, evaporation and combustible mixture formation, comparison between autoignition of homogeneous and heterogeneous mixtures, diffusion flames, combustion of liquid sprays in compression ignition engines and emission control strategies along with advances in gasoline compression ignition engines. Offered Winter.
Prerequisite: ME 7260 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

ME 8999 Master's Thesis Research and Direction Cr. 1-8
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students with a class of Candidate Masters.
Repeatable for 8 Credits

ME 9990 Pre-Doctoral Candidacy Research Cr. 1-8
Research in preparation for doctoral dissertation. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits

ME 9991 Doctoral Candidate Status I: Dissertation Research and Direction Cr. 7.5
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.

ME 9992 Doctoral Candidate Status II: Dissertation Research and Direction Cr. 7.5
Offered Every Term.
Prerequisite: ME 9991 with a minimum grade of S
Restriction(s): Enrollment is limited to Graduate level students.

ME 9993 Doctoral Candidate Status III: Dissertation Research and Direction Cr. 7.5
Offered Every Term.
Prerequisite: ME 9992 with a minimum grade of S
Restriction(s): Enrollment is limited to Graduate level students.

ME 9994 Doctoral Candidate Status IV: Dissertation Research and Direction Cr. 7.5
Offered Every Term.
Prerequisite: ME 9993 with a minimum grade of S
Restriction(s): Enrollment is limited to Graduate level students.

ME 9995 Candidate Maintenance Status: Doctoral Dissertation Research and Direction Cr. 0
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 0 Credits