Mechanical Engineering

MECH 5383 (EEMF 5383, MSEN 5383, PHYS 5383) Plasma Technology (3 semester hours) Hardware oriented study of useful laboratory plasmas. Topics will include vacuum technology, gas kinetic theory, basic plasma theory and an introduction to the uses of plasmas in various industries. (3-0) T

MECH 6300 (ENGR 6331, SYSM 6307) Linear Systems (3 semester hours) State space methods of analysis and design for linear dynamical systems. Coordinate transformations and tools from advanced linear algebra. Controllability and observability. Lyapunov stability analysis. Pole assignment, stabilizability, detectability. State estimation for deterministic models, observers. Introduction to the optimal linear quadratic regulator problem. Prerequisites: ENGR 2300 and EE 4310 or MECH 4310 or equivalent. (3-0) Y

MECH 6303 Computer Aided Design (3 semester hours) This course provides an introduction to design principles and methodologies for geometrical modeling, curve and surface fitting in an automated environment, CAD/CAM simulation of manufacturing, and computer-aided solid modeling. Prerequisite: MECH 3305 or equivalent. (3-0) Y

MECH 6306 Continuum Mechanics (3 semester hours) This course provides an introduction to mechanics of continua within a rigorous mathematical framework. Topics of interest include tensor analysis, kinematics, analysis of deformation, analysis of stress, and constitutive equations. Other areas of discussion focus on material anisotropy, mechanical properties of fluids and solids, derivation of field equations, boundary conditions, and solutions of initial and boundary value problems for continua. Prerequisite: MECH 3301 or equivalent. (3-0) Y

MECH 6307 Thermal and Energy Principles (3 semester hours) This course provides an extended treatment of the fundamentals of thermodynamics as related to energy conversion, storage, transmission and use. Industrial topics may include: conventional and sustainable power generation or efficiency in refrigeration, air-conditioning and heating applications. Further applications may include: studies of internal combustion engines, heat pump systems, and other energy conversion machines. Prerequisites: MECH 3320, MECH 3315 or equivalents. (3-0) Y

MECH 6311 Advanced Mechanical Vibrations (3 semester hours) Fundamental phenomena of multi-degree discrete and continuous systems. Matrix methods of solutions of discrete systems. Determination of natural frequencies and mode shapes of discrete and continuous systems. Passive methods of vibration control. Applications of finite element methods to analysis of mechanical vibrations. Prerequisite: MECH 4340 or equivalent. (3-0) T

MECH 6312 (EESC 6349) Random Processes (3 semester hours) Random processes concept. Stationarity and independence. Auto-correlation and cross-correlation functions, spectral characteristics. Linear systems with random inputs. Special topics and applications. Prerequisite: EE 3302 or MECH 6300 and ENG R 3341 or equivalent background in probability and statistics. (3-0) Y

MECH 6313 (BMEN 6388, ENGR 6336, SYSE 6324) Nonlinear Control Systems (3 semester hours) Differential geometric tools, feedback linearization, input-output linearization, output injection, output tracking, stability. Prerequisite: ENGR 6331 or MECH 6300 or SYSM 6307 or equivalent. (3-0) T
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<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tr>
<td>MECH 6314</td>
<td>Engineering Systems: Modeling &amp; Simulation</td>
<td>3</td>
<td>This course will present principles of computational modeling and simulation of systems. General topics covered include: parametric and non-parametric modeling; system simulation; parameter estimation, linear regression and least squares; model structure and model validation through simulation; and, numerical issues in systems theory. Techniques covered include methods from numerical linear algebra, nonlinear programming and Monte Carlo simulation, with applications to general engineering systems. Modeling and simulation software is utilized (MATLAB/SIMULINK). (3-0) Y</td>
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<tr>
<td>MECH 6316</td>
<td>Digital Control of Automotive Powertrain Systems</td>
<td>3</td>
<td>Digital control systems, discretization and design by equivalents. Input-output design and discrete-time state variable estimation and control. Introduction to various control problems in automotive powertrains. Application of digital control principles to automotive powertrains for internal combustion engine idle speed control and air-to-fuel ratio control. Prerequisites: EE 4310 or MECH 4310 or equivalents (3-0) T</td>
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<tr>
<td>MECH 6323</td>
<td>Robust Control Systems</td>
<td>3</td>
<td>Theory, methodology, and software tools for the analysis and design of model-based control systems with multiple actuators and multiple sensors. Control oriented model parameterizations and modeling errors. Definitions and criteria for robust stability and performance. Optimal synthesis of linear controllers. The loop shaping design method. Methods to simplify the control law. Control law discretization. Mechatronic design examples. Prerequisite: (MECH 6300 or ENGR 6331 or SYSM 6307) or equivalent. (3-0) T</td>
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<td>MECH 6324</td>
<td>Robot Control</td>
<td>3</td>
<td>Dynamics of robots; methods of control; force control; robust and adaptive control; feedback linearization; Lyapunov design methods; passivity and network control; control of multiple and redundant robots; teleoperation. Prerequisite: MECH 6300. (3-0) T</td>
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<tr>
<td>MECH 6330</td>
<td>Multiscale Design &amp; Optimization</td>
<td>3</td>
<td>Multi-scale systems consist of components from two or more length scales (nano, micro, meso, or macro-scales). The challenge is to make these components so they are conceptually and model-wise compatible with other-scale components with which they interface. This course covers the fundamental properties of scales, design theories, modeling methods and manufacturing issues which must be addressed in these systems. Examples include precision instruments, nanomanipulators, fiber optics, micro/nano-photonic, nanorobotics, MEMS, carbon nano-tube assemblies. Prerequisite: MECH 6303 (3-0) T</td>
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<tr>
<td>MECH 6332</td>
<td>Advanced Control</td>
<td>3</td>
<td>Modern control techniques in state space and frequency domain: optimal control, robust control, and stability. Prerequisite: ENGR 6331. (3-0) R</td>
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<tr>
<td>MECH 6333</td>
<td>Materials Design &amp; Manufacturing</td>
<td>3</td>
<td>This course provides an in-depth analysis of design problems faced in the development and mass manufacture of advanced materials. This course will explore the interplay among mathematical modeling, CAD, mold creation and manufacturing processes for polymers, ceramics and metals. Tradeoffs among various thermomechanical properties, cost and aesthetics will be studied. Prerequisite: MECH 6303 (3-0) T</td>
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<tr>
<td>MECH 6334</td>
<td>Smart Materials and Structures</td>
<td>3</td>
<td>Introduction to smart materials. Fundamental properties of smart materials including piezoelectric materials, shape memory alloys or polymers, conducting polymers, dielectric elastomers, and ionic polymer metal composites. Constitutive modeling of smart materials. Characterization techniques. Applications as sensors, actuators and in energy harvesting. Prerequisite: MECH 6306. (3-0) T</td>
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**MECH 6335 (OPRE 6340)** Flexible Manufacturing Strategies (3 semester hours) The use of automation in manufacturing is continuously increasing. This course covers the variety of types of flexible automation, including flexible manufacturing systems, integrated circuit fabrication and assembly, and robotics. Examples of international systems are discussed to show the wide variety of systems designs and problems. Strategic as well as economic justification issues are covered. (3-0) R

**MECH 6341 (EEMF 6348, MSEN 6348)** Lithography and Nanofabrication (3 semester hours) Study of the principles, practical considerations, and instrumentation of major lithography technologies for nanofabrication of devices and materials. Advanced photolithography, electron beam lithography, nanoimprint lithography, x-ray lithography, ion beam lithography, soft lithography, and scanning probe lithography, basic resist and polymer science, applications in nanoelectronic and biomaterials. (3-0) Y

**MECH 6347 (EEMF 6382, MSEN 6382)** Introduction to MEMS (3 semester hours) Study of micro-electromechanical devices and systems and their applications. Microfabrication techniques and other emerging fabrication processes for MEMS are studied along with their process physics. Principles of operations of various MEMS devices such as mechanical, optical, thermal, magnetic, chemical/biological sensors/actuators are studied. Topics include: bulk/surface micromachining, LIGA, microsensors and microactuators in multiphysics domain. (3-0) T

**MECH 6348 (EEMF 6322, MSEN 6322)** Semiconductor Processing Technology (3 semester hours) Modern techniques for the manufacture of semiconductor devices and circuits. Techniques for both silicon and compound semiconductor processing are studied as well as an introduction to the design of experiments. Topics include: wafer growth, oxidation, diffusion, ion implantation, lithography, etch and deposition. (3-0) T

**MECH 6350** Advanced Solid Mechanics (3 semester hours) This course provides a foundation for studying mechanical behavior of materials analyzing deformation and failure problems common in engineering design and materials science. Topics to be covered include elasticity, elastic stability, wave propagation, plasticity, and fracture. This course explores static and dynamic stress analysis, two- and three-dimensional theory of stressed elastic solids, analyses of structural elements with applications in a variety of fields, variational theorems and approximate solutions. Prerequisite: MECH 6306 or equivalent. (3-0) T

**MECH 6353** Computational Mechanics (3 semester hours) This course provides an introduction to nonlinear finite element methods (FEMs) for solving solid mechanics problems. Topics include total and updated Lagrangian formulations in FEMs, variational principles in continuum mechanics, FEM/meshfree shape functions and numerical discretization, adaptivity and error estimates, explicit and implicit time integration methods, stability and convergence analysis, space-time FEM formulation, Newton’s method and constraints, line-search and arc-length methods, impact and contact, computational elasticity and inelasticity. Prerequisite: MECH 6306 or equivalent. (3-0) T

**MECH 6354** Experimental Mechanics (3 semester hours) This course provides students with experimental techniques for measurements of deformations and analysis of stress in engineering materials subjected to mechanical and thermal loadings. Topics include physical mechanisms associated with design-limiting behavior of engineering materials such as stiffness, strength, toughness, and durability; basic mechanical properties of engineering materials and testing procedures used to quantify these properties; criteria for materials selection in mechanical design; and modern experimental techniques such as scanning probe microscopy, optical microscopy, nanoindentation, digital image correlation, and micro-tensile testing using
MEMS devices. Prerequisite: MECH 3301 or equivalent. (3-0) T

**MECH 6355** Viscoelasticity (3 semester hours) This course provides an overview of advanced stress analysis of solids with properties strongly influenced by time, temperature, pressure, and humidity. Topics covered include: the material characterization and thermodynamic foundation of the constitutive behavior of time-dependent materials such as polymers, and composites; time-temperature superposition principle for thermorheologically simple materials; correspondence principle; integral formulation for quasi-static boundary value problems; treatment of time-varying boundary conditions; linear viscoelastic stress waves, approximate methods of linear viscoelastic stress analysis; and introduction to nonlinear viscoelastic constitutive laws. Prerequisite: MECH 6306 or equivalent (3-0) T

**MECH 6367** (MSEN 6310) Mechanical Properties of Materials (3 semester hours) Phenomenology of mechanical behavior of materials at the macroscopic level and the relationship of mechanical behavior to material structure and mechanisms of deformation and failure. Topics covered include elasticity, viscoelasticity, plasticity, creep, fracture, and fatigue. Prerequisite: MECH 3301 or MSEN 5300 or equivalent. (3-0) R

**MECH 6368** Imperfections in Solids (3 semester hours) Point defects in semiconductors, metals, ceramics, and nonideal defect structures; nonequilibrium conditions produced by irradiation or quenching; effects of defects on electrical and physical properties, effects of defects at interfaces between differing materials. Prerequisite: MECH 6306 or equivalent. (3-0) T

**MECH 6370** Fluid Mechanics (3 semester hours) Fundamentals of fluid mechanics of Newtonian, incompressible flows in various regimes. Derivation of governing equations of motion, and introduction to viscous internal and external flows in laminar and turbulent regimes. Prerequisite: MECH 3315 or equivalent. (3-0) T

**MECH 6371** Computational Fluid Dynamics (3 semester hours) This course presents computational methods for viscous flow, boundary layer theory and turbulence. Formulation of finite element methods and other traditional numerical techniques for analysis of dynamic problems in fluid mechanics will be examined. Prerequisite: MECH 6370 or equivalent. (3-0) T

**MECH 6380** Advanced Heat Transfer (3 semester hours) This course provides an introduction to fundamentals of conductive, convective and radiative heat transfer with an emphasis on numerical and analytical solutions. Steady and transient one- and multi-dimensional thermal conduction are described. Other topics include emphasis on analytical methods, numerical techniques and approximate solutions. Prerequisites: MECH 4350, MECH 3315 or equivalents. (3-0) T

**MECH 6383** (EEMF 6383, PHYS 6383) Plasma Science (3 semester hours) Theoretically oriented study of plasmas. Topics to include: fundamental properties of plasmas, fundamental equations (kinetic and fluid theory, electromagnetic waves, plasma waves, plasma sheaths), plasma chemistry and plasma diagnostics. Prerequisite: EEGR 6316 or equivalent. (3-0) T

**MECH 6384** Applied Heat Transfer (3 semester hours) This course provides a rigorous development of heat transfer fundamentals as applied to relevant industrial problems, including heat transfer in buildings, thermal management of electronics, air conditioning & refrigeration systems and study of various thermal mechanical equipments e.g. heat exchangers and furnaces. Prerequisite: MECH 6307 or equivalent. (3-0) T
MECH 6391 (EEGR 6381) Computational Methods in Engineering (3 semester hours) Numerical techniques and their applications in engineering. Topics will include: numerical methods of linear algebra, interpolation, solution of nonlinear equations, numerical integration, Monte Carlo methods, numerical solution of ordinary and partial differential equations, and numerical solution of integral equations. Prerequisites: ENGR 2300 and ENGR 3300 or equivalents, and knowledge of a scientific programming language. (3-0) R

MECH 6v29 Special Topics in Controls and Dynamic Systems (1-6 semester hours) (May be repeated to a maximum of 9 hours.) For letter grade credit only. ([1-6]-0) R

MECH 6v49 Special Topics in Manufacturing and Design Innovation (1-6 semester hours) (May be repeated to a maximum of 9 hours.) For letter grade credit only. ([1-6]-0) R

MECH 6v69 Special Topics in Mechanics and Materials (1-6 semester hours) (May be repeated to a maximum of 9 hours.) For letter grade credit only. ([1-6]-0) R

MECH 6v89 Special topics in Thermal and Fluid Sciences (1-6 semester hours) May be repeated to a maximum of 9 hours.) For letter grade credit only. ([1-6]-0) R

MECH 6v97 Research in Mechanical Engineering (1-9 semester hours) (May be repeated for credit.) For pass/fail credit only. ([1-9]-0) R

MECH 6v98 Thesis (3-9 semester hours) (May be repeated for credit.) For pass/fail credit only. ([3-9]-0) R

MECH 8v70 Research in Mechanical Engineering (1-9 semester hours) For pass/fail credit only. May be repeated for credit. ([1-9]-0) R

MECH 8v99 Dissertation (1-9 semester hours) (May be repeated for credit.) For pass/fail credit only. ([1-9]-0) S