Mechanical Engineering

MECH 5300 (MSEN 5300 and PHYS 5376) Introduction to Materials Science (3 semester credit hours) This course provides an extensive overview of materials science and engineering and includes the foundations required for further graduate study in the field. Topics include chemical bonding, crystalline structures, imperfections and diffusion in solids, mechanical properties, strengthening and failure mechanisms, phase diagrams and transformations, corrosion and degradation of materials, metal alloys, ceramics, polymers, composites, as well as their electrical, thermal, magnetic, and optical properties. Quantitative analyses will be emphasized. (3-0) R

MECH 5370 Wind Energy Fluid Mechanics (3 semester credit hours) This course provides an introduction of the flow physics in wind turbine arrays. The main aerodynamic characteristics of a wind turbine rotor, the concept of the wind turbine wake and its evolution, characteristics of the wind field for different atmospheric conditions will be discussed for both horizontal and vertical axis wind turbines. Using conservation principles, simplified models to assess wind turbine performances will be derived such as the Blade Element Theory, power performance and the Betz limit. Computational methods for simulating wind turbine wakes, ranging from analytical wake models to more sophisticated CFD tools will be reviewed. The course will also encompass basic notions on experimental techniques to monitor wind turbine wakes through wind LiDARs and how to reproduce down-scaled experiments in a wind tunnel environment . (3-0) Y

MECH 5371 Extreme Applications in Fluid Mechanics (3 semester credit hours) What causes tornadoes, and what sustains their immensely-destructive evolution? Why do beads of water dance across lotus leaves, and how can some insects defy gravity by walking on water? Turbidity currents are violent soil-water jets that career down the walls of the ocean sea floor: what causes them? After the Deepwater Horizon oil spill, fluid dynamicists were able to accurately estimate the number of barrels of oil per day emanating from the ruptured pipe: how did they do this? Why are wing suits a precarious activity (no instructor demonstrations given). In this class, we will draw upon undergraduate-level mathematics and fluid dynamics to explain the mechanisms responsible for these (and other) extreme fluid flows. (3-0) R

MECH 5373 Thermal Management of Microelectronics (3 semester credit hours) To provide an introduction to thermal phenomena occurring in electronic equipment and to provide an understanding of how basic heat transfer principles can be applied to the thermal design of electronic packages. The course will commence with an introduction to the fundamentals of different heat transfer modes. The calculation of heat loads and temperature fields will be discussed using different cooling techniques. Includes parameter evaluation and design studies for single- and multi-chip modules, printed circuit board, and high-heat-flux cooling. Prerequisites: MECH 3320 and MECH 3351 and MECH 4310. (3-0) R

MECH 5V95 Topics in Mechanical Engineering (1-9 semester credit hours) Selected topics in mechanical engineering are covered in organized lectures. May be repeated for credit as topics vary (9 semester credit hours maximum). ([1-9]-0) R

MECH 6300 (EECS 6331 and SYSM 6307) Linear Systems (3 semester credit 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 credit 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 credit 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 3351 or equivalent. (3-0) Y

MECH 6308 Haptics and Teleoperated Systems (3 semester credit hours) This course presents an introduction to haptic systems for virtual environments and teleoperation. Course topics include: human haptics, haptic devices (design, dynamics, control, and rendering), tactile haptic displays, and teleoperation (implementation, transparency, and stability). The course will include a laboratory component, as well as a final hands-on design project. The course is also designed to improve reading and understanding of academic papers related to haptics and teleoperation, as well as to improve individual presentation skills and team-work. Prerequisites: MECH 3350 or equivalent and MECH 4310 or equivalent. (2-3) R

MECH 6309 Intermediate Dynamics (3 semester credit hours) This course covers variational principles, the principle of least action, Lagrange's and Hamilton's equations. Holonomic and nonholonomic constraints will be imposed in dynamics analysis. This course also covers coupled and uncoupled multiple degree-of-freedom linear systems, rigid body dynamics, and gyroscopic effects. Prerequisites: (MECH 2420 or equivalent) and (MECH 2330 or equivalent) and (MECH 4310 or MECH 4340) or equivalent. (3-0) R

MECH 6311 Advanced Mechanical Vibrations (3 semester credit hours) Vibration phenomena of multi-degree-of-freedom discrete and continuous systems. Lagrange's equations of motion for discrete systems. Determination of natural frequencies and mode shapes of discrete and continuous systems. Passive vibration control method. Applications of finite element methods to analysis of mechanical vibrations. Prerequisite: MECH 4340 or equivalent. (3-0) T

MECH 6312 (EESC 6349) Probability, Random Variables, and Statistics (3 semester credit hours) Probability theory, random variables, functions of random variables, random vectors, whitening transformation, law of large numbers, sample-mean estimator, confidence interval, likelihood ratio test, Chi-square test. (3-0) Y

MECH 6313 (BMEN 6388 and EECS 6336 and SYSE 6324) Nonlinear Systems (3 semester credit hours) Equilibria, phase portraits, linearization of nonlinear systems; periodic solutions; Poincare-Bendixson theorem; fundamental existence and uniqueness theorem for ODEs; Lyapunov stability theory; Invariance principle and LaSalle's theorem; converse theorems; singular perturbations; center manifold theorem; differential geometric tools, feedback linearization, input-output linearization, output injection, output tracking, passivity-based control; backstepping. Prerequisite: EECS 6331 or MECH 6300 or SYSM 6307 or equivalent. (3-0) T

MECH 6314 (BMEN 6372 and SYSM 6306 Engineering Systems: Modeling and Simulation (3 semester credit hours) 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

MECH 6316 (SYSE 6322) Digital Control of Automotive Powertrain Systems (3 semester credit hours) 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. Prerequisite: A basic course in control systems at the undergraduate level. (3-0) T

MECH 6317 (BMEN 6302 and EECS 6302 and SYSM 6302) Dynamics of Complex Networks and Systems (3 semester credit hours) Design and analysis of complex interconnected networks and systems. Basic concepts in graph theory; Eulerian and Hamiltonian graphs; traveling salesman problems; random graphs; power laws; small world networks; clustering; introduction to dynamical systems; stability; chaos and fractals. (3-0) Y

MECH 6318 Engineering Optimization (3 semester credit hours) Basics of optimization theory, numerical algorithms, and applications in engineering. The course covers linear programming (simplex method) and nonlinear programming, as well as unconstrained methods (optimality conditions, descent algorithms and convergence theorems), and constrained minimization (Lagrange multipliers, Karush-Kuhn-Tucker conditions, active set, penalty and interior point methods). Non-gradient based optimization methods are briefly introduced. Applications in mechanical engineering design will be emphasized. Students will use Matlab's Optimization Toolbox to obtain practical experience with the material. (3-0) Y

MECH 6319 Dynamics and Control of MEMS (3 semester credit hours) This course provides a comprehensive overview of Microelectromechanical Systems (MEMS) devices and their control systems. It covers topics such as MEMS fabrication processes, Sensing and actuation techniques in MEMS, Modeling and system identification of MEMS dynamics, control, signal processing, and interface electronics design for MEMS, and a number of case studies including MEMS accelerometers, gyroscopes, force sensors, pressure sensors and nanopositioners. Prerequisites:

(MECH 4310 or equivalent) and MECH 6300 or equivalents. (3-0) R

MECH 6323 (EECS 6323 and SYSE 6323) Robust Control Systems (3 semester credit hours) 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. Mechatronic design examples. Prerequisite: MECH 4310 or equivalent and MECH 6300 or EECS 6331 or SYSM 6307 or equivalent. (3-0) T

MECH 6324 (BMEN 6324 and EECS 6324 and SYSE 6326) Robot Control (3 semester credit hours) 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: EECS 6331 or MECH 6300 or SYSM 6307. (3-0) T

MECH 6325 (SYSE 6325) Optimal Estimation and Kalman Filter (3 semester credit hours) Theory, analysis, design, and implementation of Kalman filters are covered in this course together with real-world applications of the theory. Topics include a review of probability and random variables; random signals and random processes; response of linear systems to random signals; the Wiener filter; the discrete-time Kalman filter; continuous-time Kalman filter; prediction and smoothing; the extended Kalman filter; the ensemble Kalman filter; the unscented Kalman filter; case studies in GPS and GPS-aided inertial navigation, simultaneous localization and mapping (SLAM), and amplitude and phase estimation in dynamic mode atomic force microscopy (AFM). Prerequisite: MECH 6300 or instructor consent required. (3-0) R

MECH 6326 Optimal Control and Dynamic Programming (3 semester credit hours) Introduction to stochastic control, with applications taken from a variety of areas, including automatic control, engineering, supply-chain management, resource allocations, finance, etc. Markov chains and Markov decision processes, optimal policies and value functions with full state information for finite-horizon, infinite-horizon discounted, and average stage cost problems. Dynamic programming and Bellman equation, value iteration, policy iteration. Linear quadratic stochastic control. Approximate dynamic programming and model predictive control. Prerequisite: MECH 6300 or instructor consent required. (3-0) R

MECH 6327 Convex Optimization in Systems and Controls (3 semester credit hours) Introduction to convex optimization, with a focus on recognizing and solving convex optimization problems that arise in applications. Convex sets, functions, and optimization problems. Basic convex analysis. Least-squares, linear and quadratic programs, second-order cone programs, semidefinite programming. Optimality conditions, duality theory, theorems of alternative, and applications. Descent and interior-point methods. Applications in systems and control, including trajectory optimization, model predictive control, stability and control design via linear matrix inequalities, and semialgebraic techniques. (3-0) R

MECH 6328 Frequency-Domain Analysis and Design of Control Systems (3 semester credit hours) This course provides an introduction to the frequency-domain analysis tools and design methods for single-input linear feedback control systems, which will be valuable for control system design for practical applications in order to achieve the desirable performance and robustness. The topics covered in this course include: Nyquist stability criterion, stability margins on Nquist plot and Bode plot, Bode's gain-phase relationship, Frequency-domain compensator design, norms of signals and systems, internal stability, uncertainty and robustness, design constraints, loop shaping and design for performance, and model matching. (3-0) R

MECH 6330 Multiscale Design and Optimization (3 semester credit hours) 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-photonics, nanorobotics, MEMS, and carbon nano-tube assemblies. Prerequisite: MECH 6303. (3-0) T

MECH 6333 Materials Design and Manufacturing (3 semester credit hours) 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. (3-0) T

MECH 6334 Smart Materials and Structures (3 semester credit hours) 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. (3-0) T

MECH 6335 (OPRE 6340) Flexible Manufacturing Strategies (3 semester credit 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 6337 (SYSM 6301) Systems Engineering, Architecture and Design (3 semester credit hours) Architecture and design of large-scale and decentralized systems from technical and management perspectives. Systems architectures, requirements analysis, design tradeoffs, and reliability through various case studies and multiple types of mathematical techniques. International standardization bodies, including INCOSE, engineering frameworks, processes, and tool support from both theoretical and practical perspectives. (3-0) Y

MECH 6338 Reliability-Based Design (3 semester credit hours) This course covers fundamentals of reliability theory (factor of safety versus reliability, modeling uncertainty, marginal/joint random variable distributions, design process uncertainty), simulation methods and integration, computational issues for correlated random variables and large scale problems, expansion techniques, second moment methods, reliability of structural systems (response surfaces, Fast

Fourier Transform approach, series and parallel systems, system reliability), and reliability-based design optimization. Interdisciplinary engineering applications are included. (3-0) Y

MECH 6339 Multidisciplinary Design Optimization (3 semester credit hours) The objective of the course is a comprehensive introduction to the mathematical and algorithmic techniques for coupled analysis and optimization of multidisciplinary mechanical and aerospace engineering problems. The focus will be on computational methods for coupled fluid-structure interaction problems, ranging from reduced order models to full scale finite volume and finite element simulations. State-of-the-art research examples will be demonstrated in the class to develop practical insight on computational methods for engineering design. This enables the students to design advanced and complex engineering systems that are competitive in terms of performance, and have life-cycle value. At the end of the course, the student should be able to master most of the complex problems in engineering design with a deep understanding of the used optimization theory and the physics of the computational based engineering. Prerequisite: MECH 6318. (3-0) R

MECH 6341 (EEMF 6348 and MSEN 6348) Lithography and Nanofabrication (3 semester credit 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 6342 Renewable Energy and Grid Integration (3 semester credit hours) This course will discuss renewable energy and energy efficiency systems modeling, design, and optimization. After examining the technological specifications of the most important renewable energy resources (e.g., wind energy, photovoltaics, and solar thermal power) and energy efficiency technologies (e.g., energy storage, home and building energy, electric vehicles), grid integration of renewable energy and energy efficiency technologies will be examined in detail. All of these concepts will be explored in great detail and reinforced through the completion of a semester long project, where the students will be solving problems of broad interest in a group setting. Students will use Matlab and R for project design. The course builds on prerequisite knowledge in engineering system design, engineering mathematics, probability and statistics, and optimization methods. (3-0) R

MECH 6347 (EEMF 6382 and MSEN 6382) Introduction to MEMS (3 semester credit hours) Study of micro-electro-mechanical 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 and MSEN 6322) Semiconductor Processing Technology (3 semester credit 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 credit 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 2320 or equivalent. (3-0) Y

MECH 6351 Finite Element Techniques I (3 semester credit hours) This course will provide an overview on the basic theory of the finite element methods (FEM) and application of FEM analysis in solid mechanics. Course topics include 1D elements and computational procedures, variational principles and Rayleigh-Ritz method, Galerkin finite element method, numerical discretization, imposition of constraints, 2D elements and basic programing steps, finite element solution techniques, application of FEM for vibration analysis, and use of commercial FEM codes. Prerequisite: MECH 2320 or equivalent. (3-0) Y

MECH 6353 Computational Mechanics (3 semester credit hours) This course provides an in-depth discussion on Finite Element Method (FEMs) for solving solid mechanics problems. The course topics include total and updated Lagrangian formulations in finite element methods, 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, method of line-search and arc-length methods, impact and contact, computational elasticity and inelasticity. Prerequisites: MECH 6351 or equivalent. (3-0) T

MECH 6354 Experimental Mechanics (3 semester credit hours) This course provides experimental techniques and theoretical analysis for measurements of deformations and analysis of stress in engineering materials and natural bio-materials subjected to mechanical loadings. Various methods for measurement and characterization of mechanical properties such as elastic modulus, strength, failure strain, toughness, etc. will be discussed. Essential theoretical modeling for analysis of experimental results will be presented. Experimental techniques such as scanning probe microscopy, nanoindentation, and micro-tensile testing, etc. will be introduced through several lab sessions. Prerequisite: MECH 3351 or equivalent. (3-0) Y

MECH 6355 Viscoelasticity (3 semester credit 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 MECH 6350 or equivalent. (3-0) R

MECH 6356 Fracture Mechanics (3 semester credit hours) This course provides an introduction to analytical and experimental techniques for material failure by crack initiation and growth. Topics include fracture mechanics of brittle and ductile materials, asymptotic stress field in elastic and elastic-plastic materials, fracture criteria, fracture by cleavage, void growth, cohesive zone models, crack deflection, time-dependent fracture, dynamic fracture, and fatigue crack growth and life prediction. Prerequisite: MECH 6306 or MECH 6350. (3-0) T

MECH 6357 (MSEN 6380) Phase Transformations and Kinetic Processes in Materials (3 semester credit hours) This course covers diffusion, interfacial motion, nucleation, precipitation, order-disorder transitions, phase transformations, and dynamical processes at grain boundaries and on surfaces. Both macroscopic and atomic-scale approaches are used to understand these phenomena. Particular applications considered include phase transformations in bulk materials, surface evolution and thin-film growth, semiconductor processing, and nanomaterials synthesis. Prerequisites: (MECH 5300 and MSEN 5310) or equivalents. (3-0) T

MECH 6358 (MSEN 6381) Advanced Ceramic Materials (3 semester credit hours) This course covers fundamental material properties and modern applications of ceramic materials. The mechanical, optical, electronic and chemical properties of advanced ceramic materials are related to atomic structures and defects. Both conventional engineering ceramics and emerging applications of ceramics in nanotechnology, medical devices, and clean energy are reviewed. Advanced experimental and theoretical approaches in ceramics research are also discussed. Prerequisites: (MECH 5300 and MSEN 5310) or equivalents. (3-0) T

MECH 6359 (MSEN 6383) Modern Physical Metallurgy (3 semester credit hours) This course provides a basic understanding of the underlying principles that determine microstructural evolution in bulk materials and thin films during processing, and how microstructure determines their properties & performance in service. The course covers fundamental crystallography, including atomistic crystal structures and defect structures; thermodynamics and phase diagrams; kinetics of phase transformations; alloy and micro-structural engineering; and structure-property relationships that determine mechanical and electrical performance. Additionally, metallization and the reliability of multilevel interconnection and packaging for semiconductor and electronic devices are discussed. Prerequisites: (MECH 5300 and MSEN 5310) or equivalents. (3-0) R

MECH 6367 (MSEN 6310) Mechanical Properties of Materials (3 semester credit 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 2320 or MECH 5300 or equivalent. (3-0) R

MECH 6368 Imperfections in Crystalline Solids (3 semester credit hours) Basic quantitative understanding in the behavior of point, line, and planar defects in crystalline solids. Particular attention is focused on those defects that control the thermodynamic, structural, and mechanical properties of crystalline materials. Prerequisite: MECH 6306 or MECH 6350 or equivalent. (3-0) R

MECH 6370 Incompressible Fluid Mechanics (3 semester credit 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) Y

MECH 6371 Computational Thermal Fluid Science (3 semester credit 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) Y

MECH 6372 Turbulent Flows (3 semester credit hours) In the first part of the course the governing equations will be reviewed. The vorticity equation will be derived giving emphasis to the vortex stretching and vortex tilting. Classical flows such as wall bounded flows, jets, mixing layers will be reviewed and the stability of the flow and transition from laminar to turbulence will be discussed. The spectrum of turbulence kinetic energy and the budget of kinetic energy will be illustrated. The course will also cover numerical methods to simulate turbulence, including Direct Numerical Simulations (DNS), Large Eddy Simulations (LES), and Reynolds-Average Navier-Stokes (RANS) equations and models. (3-0) R

MECH 6373 Convective Heat Transfer (3 semester credit hours) The course begins by reviewing the equations of motion of viscous fluids. Energy equation that governs the heat transfer across a fluid layer is introduced. Discussion of exact and approximate solutions of forced and free convection is an integral part of the course. Laminar and turbulent flow regimes will be covered with discussions of turbulent transport and modeling. (3-0) Y

MECH 6374 Conductive and Radiative Heat Transfer (3 semester credit hours) Advanced conduction heat transfer followed by advanced radiation heat transfer. Emphasis on fundamental concepts of conduction/diffusion in heat and mass transfer including solving differential equations related to conduction. Radiation heat transfer covering black and non-black surfaces, shape factors, radiation exchange in gray diffuse enclosures, and solution methods for integro-differential equations. Multi-mode heat transfer combining conduction and radiation is also covered. (3-0) R

MECH 6375 Phase Change Heat Transfer (3 semester credit hours) Introduction to the physics and significant progresses in phase change heat transfer and two-phase flow. Boiling, evaporation and condensation heat transfer will be followed by the study of external and internal two-phase flow. Boiling includes incipience phenomena, nucleate and film boiling regimes, and critical heat flux in pool and flow boiling. Condensation includes filmwise and dropwise condensation. Selected application topics related to phase change thermal transport will also be covered. (3-0) R

MECH 6376 Experimental Thermal and Fluid Dynamics (3 semester credit hours) This course presents an introduction to experiments in thermo-fluid dynamics. Similarity theory and basic concepts to perform experiments are discussed. A description of different types of wind tunnels is given, with emphasis on the design process of a general-purpose subsonic wind tunnel. A review of the most common measurement techniques is provided, such as for fluid pressure, forces, velocity, temperature, and density. The second part of the course focuses on signal processing through statistical, spectral analysis, and modal decomposition techniques. The final part of the course is devoted to the design and execution of an experiment. (3-0) R

MECH 6377 Advanced Thermodynamics (3 semester credit hours) This course provides a more advanced study of engineering thermodynamics. It includes an examination of the fundamental concepts of classical, macroscopic thermodynamics at a level beyond what is covered in a first course. The course coverage includes additional advanced topics such as exergy, thermodynamic property relationships, gas mixtures, gas-vapor mixture properties, chemical reactions, and thermodynamics of advanced energy systems. A brief introduction to the microscopic aspects of thermodynamics will provide a foundation for understanding the principles of statistical thermodynamics. (3-0) R

MECH 6378 Introduction to Compressible Fluid Mechanics (3 semester credit hours) Introduction to the theory of compressible fluid flow. Coverage of fundamental concepts such as wave propagation in compressible media, speed of sound, Mach number, and thermodynamic relationships. This course focuses on steady, one-dimensional compressible flows and the effects of variable area, friction, and heat transfer. Normal shockwaves and the use of nozzles and diffusers are reviewed. The engineering applications of compressible flows. A brief introduction to more advanced topics such as oblique shocks will also be provided. Prerequisites: MECH 3320 and MECH 3351 and MECH 4310. (3-0) R

MECH 6383 (EEMF 6383 and PHYS 6383) Plasma Science (3 semester credit 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 6391 (EEGR 6381) Computational Methods in Engineering (3 semester credit 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 equivalent, and knowledge of a scientific programming language. (3-0) R

MECH 6V29 Special Topics in Dynamic Systems and Control (1-6 semester credit hours) Selected advanced topics in controls and dynamic systems are covered in organized lectures. May be repeated for credit as topics vary (9 semester credit hours maximum). ([1-6]-0) R

MECH 6V49 Special Topics in Manufacturing and Design Innovation (1-6 semester credit hours) Selected advanced topics in manufacturing and design innovation are covered in organized lectures. May be repeated for credit as topics vary (9 semester credit hours maximum). ([1-6]-0) R

MECH 6V69 Special Topics in Mechanics and Materials (1-6 semester credit hours) Selected topics in mechanics and materials are covered in organized lectures. May be repeated for credit as topics vary (9 semester credit hours maximum). ([1-6]-0) R

MECH 6V89 Special Topics in Thermal and Fluid Sciences (1-6 semester credit hours) Selected advanced topics in thermal and fluid sciences are covered in organized lectures. May be repeated for credit as topics vary (9 semester credit hours maximum). ([1-6]-0) R

MECH 6V95 Topics in Mechanical Engineering (1-9 semester credit hours) Selected topics in mechanical engineering are covered in organized lectures. May be repeated for credit as topics vary (9 semester credit hours maximum). ([1-9]-0) R

MECH 6V96 Individual Instruction in Mechanical Engineering (1-6 semester credit hours) Selected advanced topics in mechanical engineering. For letter grade credit only. May be repeated for credit (18 semester credit hours maximum). Instructor consent required. ([1-6]-0) R

MECH 6V97 Research in Mechanical Engineering (1-9 semester credit hours) A research project on a topic in mechanical engineering is conducted under supervision of a faculty advisor. Pass/Fail only. May be repeated for credit (18 semester credit hours maximum). Instructor consent required. ([1-9]-0) S

MECH 6V98 Thesis (3-9 semester credit hours) A research project on a topic in mechanical engineering is conducted under supervision of a supervisory committee. Research findings are documented in thesis. Pass/Fail only. May be repeated for credit. Instructor consent required. ([3-9]-0) S

MECH 7100 Seminar in Mechanical Engineering (1 semester credit hour) This course presents mechanical engineering graduate students with a wide spectrum of topics of interest to broaden knowledge beyond their specific areas of research and studies. Seminars will cover all concentration areas of research within mechanical engineering, including thermal and fluid sciences; dynamical systems and control; manufacturing and design innovation; and mechanics and materials. Pass/Fail only. May be repeated for credit as topics vary (9 semester credit hours maximum). (1-0) S

MECH 7392 Advanced Mathematics for Mechanical Engineers I (3 semester credit hours) Linear algebra and matrix analysis, tensor analysis, multivariable calculus and analytic geometry, vector integral calculus, closed-form and numerical solutions of ordinary differential equations, and stability. Prerequisites: PhD students or department consent required. (3-0) R

MECH 7393 Advanced Mathematics for Mechanical Engineers II (3 semester credit hours) Special functions, complex functions, complex integrals, conformal mapping, Fourier series, Fourier and Laplace transforms, systems of nonlinear equations, closed form, and numerical solutions of partial differential equations. Prerequisites: PhD students or department consent required. (3-0) R

MECH 7V29 Advanced Special Topics in Dynamic Systems and Control (1-6 semester credit hours) Selected contemporary topics in dynamic systems and controls are covered in organized lectures. May be repeated for credit as topics vary (9 semester credit hours maximum). ([1-6]-0) R

MECH 7V49 Advanced Special Topics in Manufacturing and Design Innovation (1-6 semester credit hours) Selected contemporary topics in manufacturing and design innovation are covered in organized lectures. May be repeated for credit as topics vary (9 semester credit hours maximum). ([1-6]-0) R

MECH 7V69 Advanced Special Topics in Mechanics and Materials (1-6 semester credit hours)

Selected contemporary topics in mechanics and materials are covered in organized lectures. May be repeated for credit as topics vary (9 semester credit hours maximum). ([1-6]-0) R

MECH 7V89 Advanced Special Topics in Thermal and Fluid Sciences (1-6 semester credit hours) Selected contemporary topics in thermal and fluid sciences are covered in organized lectures. May be repeated for credit as topics vary (9 semester credit hours maximum). ([1-6]-0) R

MECH 8V70 Advanced Research in Mechanical Engineering (1-9 semester credit hours) A research project on an advanced topic in mechanical engineering is conducted under supervision of a faculty advisor. Pass/Fail only. May be repeated for credit. Instructor consent required. ([1-9]-0) S

MECH 8V99 Dissertation (1-9 semester credit hours) A research project on an advance topic in mechanical engineering is conducted under the supervision of a supervisory committee. Research findings are documented in dissertation. Pass/Fail only. May be repeated for credit. Instructor consent required. ([1-9]-0) S