ME - Mechanical Engineering

Courses numbered 100 to 299 = *lower-division*; 300 to 499 = *upper-division;* 500 to 799 = *undergraduate/graduate*.

ME 250. Materials Engineering (3).
Introduces the basic principles behind materials science and engineering. Structure and properties of materials relevant to practicing engineers are looked at along with crystal structure and imperfections in metals. Studies diffusion mechanical properties, failure mechanisms, phase equilibrium diagrams and heat treatment principles for steels, cast irons, and other metal alloys. Provides the scientific foundation for an understanding of the relationships among material properties, structure and performance for the classes of engineering solids (metals and alloys, polymers, ceramics, semiconductors, etc.). Includes study of corrosion, atomic structure, mechanical properties, failure theories, fatigue, creep, cold working, heat treating, alloying, and nondestructive and other material testing. Students are expected to gain an understanding of these materials, processing techniques, their properties, and how they are applied in the industry. Prerequisite(s): CHEM 211, MATH 242.

ME 251. Materials Engineering Laboratory (1).
Experimental study and macroscopic mechanical response of ceramics, metals, polymers and composite materials, with an introduction to the underlying microstructural processes during deformation and fracture. The laboratory is designed to introduce students to some of the most common materials testing and characterization methods. Topics include optical metallography, tensile and compression testing, hardness testing, impact testing, fatigue testing, heat treating, scanning electron microscopy, plastic injection molding, melting and casting. Pre- or corequisite(s): ME 250.

ME 281I. Noncredit Internship (0).
Complements and enhances the student's academic program by providing an opportunity to apply and acquire knowledge in a workplace environment as an intern. Prerequisite(s): departmental consent.

ME 320. Badge: Mechanical Engineering Topics (0.5).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 320A, 320B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Graded Bg/NBg.

ME 320BA. Badge: Linear Systems for Engineers (0.5).
Provides the essential knowledge of linear systems, aimed at understanding, analyzing and designing various mechanical engineering systems. Students learn matrix definition, build, property and operation as basic engineering mathematical tools, and their practical applications to various mechanical engineering systems. May be "stacked" with ME 320BB, 320BC, 320BD, 320BE and 320BF for ME 325 credit. Graded Bg/NBg. Prerequisite(s): students must possess basic math skills in algebra before enrolling.

ME 320BB. Badge: Computer Programming for Engineers (0.5).
Provides basic computer programming skills using a user-friendly programing language, i.e., MATLAB. Students learn practical skills such as developing computer codes to numerically solve engineering problems. Includes data types, flow control, functions, plotting, simulation and numerical methods. May be "stacked" with ME 320BA, 320BC, 320BD, 320BE and 320BF for ME 325 credit. Graded Bg/NBg. Prerequisite(s): students must possess basic numerical analysis and interpreting skills before enrolling.

ME 320BC. Badge: Numerical Analysis for Engineers (0.5).
Provides the principles of evaluating numerical differentiation, integration, and interpolation. Students also practice how to estimate the numerical accuracy using relative error. May be "stacked" with ME 320BA, 320BB, 320BD, 320BE and 320BF for ME 325 credit. Graded Bg/NBg. Prerequisite(s): students must possess basic math skills in algebra and calculus, and a basic understanding of Newton’s second law before enrolling.

ME 320BD. Badge: Root Finding for Engineers (0.5).
Provides the basic principle of root finding method (solving nonlinear equations) to solve various mechanical engineering problems. Students practice how to implement the mathematical principles into user-friendly computer code, i.e., MATLAB, to numerically solve nonlinear equations. May be "stacked" with ME 320BA, 320BB, 320BC, 320BE and 320BF for ME 325 credit. Graded Bg/NBg. Prerequisite(s): students must possess basic math skills in algebra and calculus, and elementary computer programming skills before enrolling.

ME 320BE. Badge: Optimization for Engineers (0.5).
Provides the basic principles of optimization and practices to optimally design mechanical engineering systems. Students learn how to implement the mathematical principles into user-friendly computer code, i.e., MATLAB, to numerically determine optimal engineering solutions. May be "stacked" with ME 320BA, 320BB, 320BC, 320BD and 320BF for ME 325 credit. Graded Bg/NBg. Prerequisite(s): students must possess basic math skills in algebra and calculus, and rudimentary computer programming skills before enrolling.

ME 320BF. Badge: Numerical Differential Equations for Engineers (0.5).
Provides the basic principles of solving differential equations using numerical methods to solve various mechanical engineering problems. Students practice how to implement the mathematical principles into user-friendly computer code, i.e., MATLAB, to numerically solve differential equations. May be "stacked" with ME 320BA, 320BB, 320BC, 320BD and 320BE for ME 325 credit. Graded Bg/NBg. Prerequisite(s): students must possess basic math skills in algebra and calculus, and elementary understanding of Newton’s second law and physical properties such as temperature, pressure, displacement, velocity and acceleration before enrolling.

ME 325. Numerical Methods for Engineers (3).
Provides the basic numerical methods to understand, analyze and design the various engineering systems. Includes linear systems of equations, least square problems, eigenvalue problems, singular value problems, and ordinary differential equations. Students learn not only basic principles of numerical analysis, but also practical applications to the various numerical problems through commercially available computer software, e.g., MATLAB. Prerequisite(s): ECE 282 and MATH 555.

ME 335. Dynamics for Mechanical Engineers (3).
Kinematics and kinetics of particles in space and rigid bodies in plane motion. Applications of the principles of Newton's laws, work-energy, impulse-momentum, and conservation laws to solve mechanical systems with prismatic joints, revolute joints, cylindrical joints, and rolling joints. Lectures and projects on modeling and simulation of mechanical systems using multibody dynamic software. Prerequisite(s): AE 223 and MATH 344.

ME 339. Design of Machinery (3).
Introduces engineering design process; synthesis and analysis of machinery and machines. Kinematic (position, velocity and acceleration) and inverse dynamic analysis of planar mechanisms by analytical, graphical and computer methods. Design of linkages for motion, path and function generation; cam design. Computer-aided engineering approach in mechanical design; projects on practical

engineering designs for machinery. Prerequisite(s): IME 222 and ME 335, both with a GPA of 2.000 or above.

ME 360. Selected Topics in Mechanical Engineering (1-3).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 360A, 360B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Prerequisite(s): as published or departmental consent.

ME 398. Thermodynamics I (3).
An introduction to the terminology and analysis techniques specific to thermodynamics centered around a study of the first and second laws of thermodynamics. Prerequisite(s): MATH 243, PHYS 313.

ME 439. Mechanical Engineering Design I (3).
Provides students with an understanding of various design concepts related to failure and stress analysis of the most widely used machine elements and components. Covers the basics of machine design including the design process, engineering mechanics and materials, failure prevention under static and variable loading conditions, design of mechanical components, and selection of materials and mechanical components from standard tables, charts, catalogs and handbooks. Offers a practical approach to the design subject through a wide range of real-world applications and examples. Prerequisite(s): ME 250, ME 251, AE 333 and MATH 555.

ME 450. Selected Topics in Mechanical Engineering (1-3).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 450A, 450B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Prerequisite(s): departmental consent.

ME 475. Integrated Design and Manufacturing (3).
Fundamentals of manufacturing processes including forming, machining, casting and welding with emphasis on design considerations in manufacturing. Mechanical behavior of metallic materials. Modern manufacturing practices. Integration of materials, design and manufacturing. Materials selection. The layout and design of tooling, jigs, fixtures, gages and equipment through computer-aided design techniques. Design for assembly and manufacturing (DFMA) to facilitate cost-effective manufacturing using material selection. Concepts and applications of micro/nanotechnology appropriate to the manufacturing field. An overview of micro/nano-fabrication techniques including mechanical, EDM, laser and lithography and MEMS device fabrication. Scaling laws. Top down and bottom up approaches of nanomanufacturing. Prerequisite(s): ME 250, ME 251, AE 333; all with a GPA of 2.000 or above. Pre- or corequisite(s): ME 439. Corequisite(s): ME 475L.

ME 481A. Cooperative Education (1-3).
Academic program that expands a student's learning experiences through paid employment in a supervised educational work setting related to the student's major field of study or career focus. Intended for students who are working full time on their co-op assignments and do not need to be enrolled in any other course. Repeatable for credit. Prerequisite(s): junior standing and approval by the appropriate faculty sponsor.

ME 481I. Noncredit Internship (0).
Complements and enhances the student's academic program by providing an opportunity to apply and acquire knowledge in a workplace environment as an intern. Prerequisite(s): departmental consent.

ME 481N. Internship (1).
Complements and enhances the student's academic program by providing an opportunity to apply and acquire knowledge in a workplace environment as an intern. Prerequisite(s): departmental consent.

ME 481P. Cooperative Education (1).
Academic program that expands a student's learning experiences through paid employment in a supervised educational work setting related to the student's major field of study or career focus. Intended for students who are working part time on their co-op assignments and are currently enrolled in courses leading to a mechanical engineering degree. Repeatable for credit. Prerequisite(s): junior standing and approval by the appropriate faculty sponsor.

ME 502. Thermodynamics II (3).
Continuation of ME 398, emphasizing cycle analysis, thermodynamic property relationships and psychrometrics, with an introduction to combustion processes and chemical thermodynamics. For undergraduate credit only. Prerequisite(s): ME 398.

ME 521. Fluid Mechanics (3).
Covers the definition of a fluid and the concept of a continuum; stress and strain in a Newtonian fluid; description and classification of fluid motions; hydrostatic pressure and forces on submerged surfaces; and Reynolds Transport Theorem and integral analysis of conservation laws. The course is an introduction to differential analysis of fluid motion and dimensional analysis and similitude. Studies flow in closed conduits: pressure drop in fully developed viscous flow. The boundary layer concept and lift and drag forces on immersed bodies is also covered. For undergraduate credit only. Prerequisite(s): ME 335, ME 398, MATH 555; all with a minimum grade of C (2.000). Corequisite(s): ME 521L.

ME 522. Heat Transfer (3).
Introduction to the three modes of heat transfer in the context of the laws of thermodynamics; the heat equation and its application to steady conduction in one- and two-dimensions as well as to unsteady one-dimensional conduction; the thermal boundary layer, Reynolds Analogy, and the problem of convection; free and forced convection in internal and external flows; boiling and condensation; thermal radiation. Emphasizes problem solving using analytical methods, approximate solutions, analogies, empirical correlations and numerical methods. For undergraduate credit only. Prerequisite(s): ME 521 and PHYS 314, both with a minimum grade of C (2.000). Pre- or corequisite(s): ME 325.

ME 533. Mechanical Engineering Laboratory (3).
Introduces the basics of engineering measurements. Discusses related theory, followed by applications in such areas as strain, sound, temperature and pressure measurements. Format includes lectures, recitation (presenting the concept of the experiment to be performed and the required data analysis), and laboratories. Analyzes the data obtained from measuring systems set up and operated in the laboratory to demonstrate and reinforce fundamental concepts of engineering mechanics. For undergraduate credit only. Prerequisite(s): ECE 282, AE 333, ME 325, ENGL 102, COMM 111, PHYS 315. Pre- or corequisite(s): ME 522. Corequisite(s): ME 533L.

ME 541. Mechanical Engineering Design II (3).
Continues on the basis of applications of engineering design principles, engineering analytical skills and failure theories, to the creative design of mechanical assemblies and equipment. Using the basics of machine design (e.g., design process, engineering mechanics and materials, failure prevention under static and variable loading), students learn to examine the safety of the structure, leading to decision making and selection of mechanical components and standard parts (e.g., shafts, bearings, fasteners, gears, springs, sprockets, breaks and clutches),

according to the available standards, codes, handbooks and catalogs. Problem definition, conceptual design, feasibility studies, design calculations to obtain creative solutions for current real engineering problems, introduction to human factors, economics and reliability theory are part of the experience through group and/or individual design projects. For undergraduate credit only. Prerequisite(s): ME 339 and ME 439, both with a GPA of 2.000 or above. Pre- or corequisite(s): ME 475 with a GPA of 2.000 or above.

ME 581. Introduction to Corrosion (3).
Presents information about basic corrosion processes, underlying principles of corrosion formations, and general protection methods. Studies basic corrosion and corrosion mechanisms, importance of corrosion, coating systems, and how the materials are protected from the corrosion formations. Concerns fundamental theory of the thermodynamics and kinetics of the corrosion process of metals and alloys as well as polymer materials both in atmosphere and water solutions. Focuses on electrochemical aspects and the influences of the properties of the metals and their oxides on the corrosion behavior, which is exemplified by different corrosion types. Existing corrosion protection strategies, including surface treatments and coatings are described and choice of material is discussed from a corrosion point of view. Prerequisite(s): ME 250 and ME 398; or instructor’s consent.

ME 602. Engineering for the Environment (3).
Basic principles of conservation of mass and chemistry as relevant to environmental processes, both natural and engineered, are reviewed. The course also covers air and water pollution, along with the major pollutants, their health effects, their sources, their transport and attainment/remediation technologies. Additional topics include solid and hazardous waste, major greenhouse gases and climate change, environmental justice, and Life Cycle Assessment. Students work in teams on a term project to perform in-depth research on an environmental problem currently in need of a solution. This course satisfies the ME departmental criteria for an ME elective, or a thermal/fluids/energy/environment elective, or an open technical elective course required for graduation. Prerequisite(s): ME 398 (or CHEM 211) and MATH 243 (with a grade not lower than one that generates 2.000 or more credit points per credit hour), or instructor’s consent.

ME 625. Applications in Thermal Engineering (3).
Application of energy concepts to thermal fluid applications. Open-ended problems in incompressible and compressible fluid flows, boundary layer modeling and analogies, LMTD, heat exchangers, pumps and turbines, modeling and prototype, and gas radiation. Theoretical analysis and report preparation. For undergraduate credit only. Prerequisite(s): ME 521 and ME 522; both with a GPA of 2.000 or above. Pre- or corequisite(s): ME 533.

ME 633. Mechanical Engineering Systems Laboratory (3).
Selected experiments illustrate the methodology of experimentation as applied to mechanical and thermal systems. Experiments include the measurement of performance of typical systems and evaluation of physical properties and parameters of systems. Group design and construction of an experiment is an important part of the course. Team and individual efforts are stressed as are written and oral communication skills. For undergraduate credit only. Prerequisite(s): ME 522, ME 533. Corequisite(s): ME 633L.

ME 637. Computer-Aided Engineering (3).
Integrates computer-aided design, finite element analysis, kinematics analysis, heat transfer analysis and other considerations for design of mechanical components and systems. Provides a blend of theory and practice. Prerequisite(s): ME 339 and ME 439, or equivalent. Corequisite(s): ME 637L.

ME 644. Design of HVAC Systems (3).
Analysis and design of heating, ventilating and air-conditioning systems based on psychometrics, thermodynamics and heat transfer fundamentals with focus on advanced duct design for composite building, cooling load calculations and thermal-issues based psychometric. Focuses on design procedures for space air-conditioning, and heating and cooling loads in buildings. Prerequisite(s): ME 521, 522; or instructor's consent.

ME 650. Selected Topics in Mechanical Engineering (1-3).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 650A, 650B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Prerequisite(s): departmental consent.

ME 651. Biomaterials (3).
Introduction to biomaterials and biotechnology for both undergraduate and graduate students focusing on biomaterials (e.g., metals and alloys, composites, polymers and ceramics), biodevices, basic fabrication and characterization techniques, and their general properties and applications. Prerequisite(s): ME 250, ME 251; or instructor's consent.

ME 659. Mechanical Control Systems (3).
Modeling and simulation of dynamic systems. Theory and analysis of the dynamic behavior of control systems, based on the laws of physics and linear mathematics. Concerns classical methods of feedback control systems and design. Prerequisite(s): (1) ECE 282 and MATH 555, or (2) ECE 383.

ME 660. Polymer Materials and Engineering (3).
Introduces the basic science and engineering of polymer materials. Provides the scientific foundation for an understanding of the relationships among material structures and properties of different types of polymer materials (thermoplastics, thermosets, synthetic fibers and rubbers, etc.) for various applications from consumer electronics to aviation industry. An understanding of these materials, processing techniques, their properties, and how they are applied in the industry. Prerequisite(s): ME 250 or CHEM 211.

ME 662. Senior Capstone Design (3).
Culminating course allows students nearing graduation to combine the knowledge and skills acquired in their program and apply them to a major project or assignment. Exercise in the practice of mechanical engineering for undergraduate students in their graduating semester; students engage in a comprehensive design project requiring the integration of knowledge gained in prerequisite engineering, science and design courses along with economic comparisons of engineering alternatives considering the time value of money, taxes and depreciation. Team effort and both oral and written presentations are a part of the experience. This course has a lab component. For undergraduate credit only. Capstone course. Prerequisite(s): PHIL 385 and ME 475, with a GPA of 2.000 or better. Pre- or corequisite(s): ME 633 and ME 659.

ME 665. Selection of Materials for Design and Manufacturing (3).
Focuses on the selection of engineering materials to meet product and manufacturing requirements. Solution to various product and manufacturing problems by appropriate selection of materials is illustrated through the use of numerous examples and case studies. Prerequisite(s): ME 439.

ME 667. Mechanical Properties of Materials (3).
Major focus on deformation mechanisms and on crystal defects that significantly affect mechanical properties. Also covers plasticity theory, yield criteria for multi-axial states of stress, fracture mechanics

and fracture toughness. Includes some review of basic mechanics of materials and elasticity as needed. Prerequisite(s): ME 439.

ME 670. Introduction to Nanotechnology (3).
Introduction to the underlying principles and applications of the field of nanotechnology and nanoscience. Covers basic principles of nanotechnology, nanomaterials and associated technologies and provides a background of the understanding, motivation, implementation, impact, future, and implications of nanotechnology. Focuses on processing techniques of nanoparticles, nanofibers/wires, nanotubes, nanofilms and nanocomposites using physical, chemical and physicochemical techniques, as well as their characterizations and potential commercial applications. An understanding of nanomaterials, fabrication and characterization techniques, and how they are applied in nanodevice fabrication. Material covered includes nanofabrication technology (how one achieves the nanometer length scale, from "bottom up" to "top down" technologies), the interdisciplinary nature of nanotechnology and nanoscience (including areas of chemistry, material science, physics and molecular biology), examples of nanoscience phenomena (the crossover from bulk to quantum mechanical properties), and applications (from integrated circuits, quantum computing, MEMS and bioengineering). Prerequisite(s): ME 250 and ME 398; or instructor’s consent.

ME 671. Fluid Machinery (3).
A second course in fluid mechanics for undergraduate students in mechanical engineering. Covers pumps, turbines, wind turbines, and other hydraulic machinery and flow measurement devices as appropriate. Based on principles of conservation of mass, momentum, and energy; dimensionless parameters and similitude for modeling and scaling; vector diagrams; and design and optimization. Prerequisite(s): ME 521 with a minimum grade point of 2.000.

ME 672. Manufacturing of Composites (3).
Provides the basis for understanding and use of composite materials in various engineering applications such as space and aerospace structures. Different classes of composite materials, the characteristics of their constituents, an introduction to micromechanics of composites, commonly used composite manufacturing techniques in detail, along with their capabilities and limitations, characterization methods, degradation, joining, tooling, machining, and recycling of composites is discussed. Contains laboratory modules designed to provide hands-on experience to emphasize the practical aspects of the topics covered. Prerequisite(s): ME 250, ME 251, AE 333; or instructor's consent.

ME 680. Laser Materials Processing and Design (3).
Studies laser science such as the methods, processes or products that make use of the spectrum of laser light. Covers laser processing to produce features and modify properties in metals, organic polymers, inorganic insulators, superconductors, semiconductors and biological materials on the meso/micro/nano scales. Research into laser nano/micro materials processing in electronic, opto-electronic, MEMS, medical-therapeutic and other applications. Finite volume-based software Flow 3D is part of the lab experience. Prerequisite(s): ME 398 or instructor's consent. Corequisite(s): ME 680L.

ME 680L. Laser Materials Processing and Design Lab (0).
Studies laser science such as the methods, processes or products that make use of the spectrum of laser light. Covers laser processing to produce features and modify properties in metals, organic polymers, inorganic insulators, superconductors, semiconductors and biological materials on the meso/micro/nano scales. Research into laser nano/micro materials processing in electronic, opto-electronic, MEMS, medical-therapeutic and other applications. Finite volume-based software Flow 3D is part of the lab experience. Corequisite: ME 680.

ME 690. Fundamental Electrochemistry (3).
An introduction to the fundamentals of electrochemistry, focusing on the connection with thermal chemistry and energy conversion. Electrochemistry section focuses on the thermodynamics of electrochemical cells, the rise of electrical potential, standard reduction potentials, reference electrodes, kinetics of electrode reactions, mass transfer by diffusion, and double-layer structure and adsorption. Electrochemical techniques focuses on potential sweep methods, current techniques covering the fundamental electrochemistry, forced convection method, and impedance. Mathematical methods and digital simulations of electrochemical processes are also introduced. Prerequisite(s): ECE 282, ME 521; all with a GPA of 2.000 or above.

ME 702. Energy and Sustainability (3).
Cross-listed as PHYS 702. Introduces sustainability in a world of increasing population with more energy intensive lifestyles and diminishing resources; anthropogenic global climate change and the engineer's responsibilities; estimating our carbon footprint; surveys alternative energy sources with special emphasis on wind and solar energy; life cycle analysis (LCA) of engineered products; the electric grid; emissions from various transportation modes, and alternatives. Consists of traditional lectures, seminars by invited experts, and case studies. Meets the ME undergraduate curricular requirement for thermal/fluids elective and/or a general ME elective. Pre- or corequisite(s): ME 522 or PHYS 551; or instructor's consent.

ME 709. Injury Biomechanics (3).
Offers insight into the trauma problem and methods used to quantify and reduce it. Research methods used in injury biomechanics and their limitations are discussed including tests with human volunteers, cadavers, animals, mechanical crash test dummies and computer models. Provides a basic understanding of injury mechanisms and tolerances for the different body parts, including head, spine, thorax and extremities. Presents both automotive and aircraft impact safety regulations on occupant protection and related biomechanical limits. Students are exposed to and gain experience in using mathematical/numerical/computer models for injury biomechanics. Prerequisite(s): instructor's consent.

ME 710. Six Sigma for Mechanical Engineers (3).
Introduces the basic principles behind six sigma engineering as applicable to mechanical engineering. Provides the scientific foundation for an understanding of the six sigma tools and principles and applications towards design and development of mechanical components, ensuring regulatory compliance through qualification and validation by identifying manufacturing issues, developing advanced manufacturing cost-effective solutions, and overseeing successful implementation into production, eliminating waste to reduce overhead motive, cost, etc. Uses a set of management methods, mainly empirical and statistical methods, and creates a special infrastructure of people within the organization who are experts in these methods. Students gain an understanding of how six sigma improves the quality of the output of a process by removing the causes of defects and minimizing variability in the various facets of mechanical engineering related to industry. Pre- or corequisite(s): ME 339 and MATH 555, both with a GPA of 2.000 or above; or graduate status.

ME 719. Basic Combustion Theory (3).
Introduces the fundamental principles of combustion processes. Examines the chemistry and physics of combustion phenomena, that is, detonation and flames, explosion and ignition processes. Prerequisite(s): CHEM 211, ME 522.

ME 725. Mechanical Vibrations and Acoustics (3).
Studies free and forced vibrations of damped and undamped single and multiple degrees of freedom discrete mechanical systems, vibration isolation, rotating imbalance, psychophysiological acoustics, noise

emission assessment, types of sound waves and their sources, sound reflection/absorption/transmission/diffraction, sound propagation in porous materials and multilayered walls, sound propagation in ducts, silencer design, and mechanisms for acoustic radiation from a vibrating surface. Prerequisite(s): ME 325, ME 335, MATH 555; or instructor's consent.

ME 728. Advanced Electronic Materials (3).
Focuses on electronic materials which are fundamental and critical to performances and applications of electronic devices. Structure-property and property-relationships of different types of electronic materials are discussed. Cutting edge technologies in development of advanced electronic materials and devices are introduced. High level knowledge of electronic material structures, properties and applications of electronic materials, and basic principles for material design for electronics. Prerequisite(s): ME 250 or PHYS 313; or instructor's consent.

ME 729. Computer-Aided Analysis of Mechanical Systems (3).
Modeling and analysis of planar motion for multibody mechanical systems including automatic generation of governing equations for kinematic and dynamic analysis, as well as computational methods and numerical solutions of governing equations. Computer applications. Open-ended student projects on engineering applications such as mechanisms design and vehicle dynamics. Technical elective course for mechanical engineering students. Prerequisite(s): ME 339, MATH 555 or instructor's consent.

ME 730. Modeling of Engineering Systems (3).
Provides rigorous understanding of physics and engineering mathematics in order to model practical scientific and engineering problems in fluid mechanics, heat transfer, solid mechanic, and vibrations. Focuses on analytical approaches and introduces computational methods for modeling engineering systems using computer codes. Prerequisite(s): MATH 555 and ME 325, or departmental consent.

ME 731. Advanced Heat Exchanger Design (3).
Topics cover advanced design of fluidized bed, heat pipe, and high-temperature heat exchangers. Design experience through individual projects. Prerequisite(s): ME 521, ME 522.

ME 737. Robotics and Control (3).
Systems engineering approach to robotic science and technology. Fundamentals of manipulators, sensors, actuator, end-effectors and product design for automation. Includes kinematics, trajectory planning, control, programming of manipulator and simulation, along with introduction to artificial intelligence and computer vision. Prerequisite(s): ECE 282, ME 335, ME 339, MATH 555 or graduate status.

ME 740. Indoor Air Pollution and Simulation (3).
This course focuses on air pollution in building indoors and modeling topics with an emphasis on how air quality models can be used to help inform decision makers. In addition to introducing the fundamentals of air pollution and addressing general modeling considerations, topics covered in this course include the health and environmental effects of key air pollutants, how air quality modeling was used in major studies leading to better air quality. Specific modeling topics include box and plume modeling, indoor air quality and monitoring, numerical and statistical modeling. Prerequisite(s): ME 398 and ME 521 with a GPA of 2.000 or better in both courses, or graduate status.

ME 745. Design of Thermal Systems (3).
Covers component design for a typical Rankine power cycle. Design of boilers, condensers, various types of turbine, pipe flow network, and power plant system integration are covered. Prerequisite(s): ME 521, ME 522.

ME 749. Applications of Finite Element Methods in Mechanical Engineering (3).
Introduces the finite element method (FEM) as a powerful and general tool for solving differential equations arising from modeling practical engineering problems. Finite element solutions to one- and two-dimensional mechanical engineering problems in mechanical systems, heat transfer, fluid mechanics and vibrations. Includes Galerkin's and variational finite element models. Introduces commercial finite element computer tools such as ANSYS. Prerequisite(s): ME 325 and ME 439. Pre- or corequisite(s): ME 522 or graduate status. Corequisite(s): ME 749L.

ME 750. Selected Topics in Mechanical Engineering (1-3).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 750A, 750B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Prerequisite(s): departmental consent.

ME 750AK. Engineering Applications of Machine Learning (3).
Introduces fundamental concepts of machine learning and demonstrates their application to engineering problems commonly encountered in mechanical engineering and related fields. The course covers supervised and unsupervised learning paradigms, linear and nonlinear models, data preparation, feature engineering, model evaluation, and an introduction to deep learning. Applications are drawn from areas such as mechanical, electrical, thermal, optical, magnetic and corrosion-related properties, as well as manufacturing, automotive, nanotechnology, healthcare, energy, aerospace and materials engineering. Throughout the course, students gain an understanding of how machine learning methods are developed, evaluated and applied in modern engineering practice. Prerequisite(s): CHEM 211 and ME 730 or MATH 511; graduate standing or instructor's consent.

ME 752. Failure Analysis Methods and Tools (3).
Introduces the fundamental concepts of the failure analysis of engineering components at various environmental and testing conditions, and provides general knowledge on the procedures and mechanisms involved in failure analysis. Topics include procedural approaches in failure analysis; metallographic and fractographic studies, analysis of broken components by macroscopic, microscopic and nanoscopic observations, reviews common experimental methods used in failure analysis, and specific descriptions of failures for metallic, ceramics, polymeric and composite materials at micro- and nanoscales. Students learn advanced materials characterization techniques including scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS) and compositional dot mapping, x-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR) optical microscopy, and fracture surface sample preparation. Undergraduate and graduate students are expected to gain an understanding of these subjects, and how they are applied in industrial applications. Prerequisite(s): ME 250, and ME 439; or instructor's consent.

ME 753. Advanced Materials for Energy Systems (3).
Introduces the advanced materials and fundamental principles behind the energy systems and devices. Focuses on advanced materials (e.g., metals and alloys, composites, polymers, ceramics and semiconductors) at micro- and nanosize, novel energy conversion systems and devices, fabrication and characterization techniques and their general properties and applications. Efficiencies of most energy systems are limited by materials engineering and reliability of these systems. Covers the application of scientific and engineering principles for materials used in energy systems. Equips students with knowledge and skills that enable them to solve a wide range of energy materials technology and

engineering problems to minimize operational risks and maximize process reliability, and ensure a more sustainable future. Students gain an understanding of these advanced materials and devices, importance of them, and how they are applied in energy related technologies and future developments. Prerequisite(s): ME 250, ME 398 and ME 522; or instructor's consent.

ME 758. Nonlinear Controls of Electro-Mechanical Systems (3).
Standard first nonlinear controls course. Covers stability, feedback linearization (robotic, mechanical, electro-mechanical system applications), differentially-flat systems (with rotor-craft position tracking applications), back-stepping control-design methods (electro-mechanical, robotic and rotor-craft applications), MIMO systems, normal form, zero dynamics, and adaptive control of robotic systems. ECE 792, Linear Systems, while not a prerequisite, is helpful. Prerequisite(s): ME 659 or ECE 684; or equivalent.

ME 760. Fracture Mechanics (3).
Covers fracture mechanics in metals, ceramics, polymers and composites. Suitable for graduate and undergraduate study in metallurgy and materials, mechanical engineering, civil engineering and aerospace engineering where a combined materials-fracture mechanics approach is stressed. Prerequisite(s): ME 439 or instructor's consent.

ME 761. Autonomous Vehicles (3).
Overview of the concepts required to create autonomous vehicles. Introduces topics such as sensing, localization, perception, deep learning for motion planning, decision making, object recognition and intelligent control. Discusses core mechanical principles like dynamics, control systems and robotics, alongside specialized topics such as sensor technology, path planning and vehicle architecture. Also integrates crucial modern elements like machine learning, AI, and the software-hardware integration necessary for self-driving functionality. Pre- or corequisite(s): ME 659 .

ME 762. Polymeric Composite Materials (3).
Designed to provide students with an understanding and knowledge about polymeric composite materials. The characteristics of various reinforcements and polymeric matrices are presented and their processing techniques, capabilities and limitations are highlighted. In addition, various methods for manufacturing of polymeric composites along with their capabilities are discussed. Characterization techniques, test methods, assembly and joining of polymeric composites are presented. Prerequisite(s): AE 333 or equivalent; or graduate standing; or instructor's consent.

ME 770. Transport in Porous Media (3).
Studies the fundamentals of heat and mass transport in porous media including single- and multiphase flows and conduction/ convection/radiation, and phase change heat transfer in energy, thermal management, water desalination and filtration systems. Prerequisite(s): ME 522 with a minimum grade point of 2.000, or graduate standing .

ME 775. Introduction to Microelectromechanical Systems (3).
Introduces the design and manufacture of microelectromechanical systems, including principles of MEMS sensing and actuation, microfabrication and packaging. Covers electrical, thermal and mechanical behavior of microsystems, the design of electromechanical and thermal sensors and actuators, MEMS microfabrication, and MEMS packaging techniques. Studies a variety of microscale sensors and actuators (e.g., electrical switches, pressure sensors, inertial sensors and optical MEMS). Devotes the last third of the semester largely to design. Prerequisite(s): ME 439, ME 533, and MATH 555 with a minimum of C or better; or graduate standing.

ME 777. Mechanical Engineering Seminar (0).
A mechanical engineering graduate seminar to develop critical thinking/ foundation for students' future professional careers with cutting-edge research activities in the area of mechanical engineering. Provides the necessary scientific and mechanical engineering knowledge for future successful professionals. Students are required to register and pass this course at least one semester during their entire graduate study. Course meets biweekly per semester. Repeatable.

ME 779. Phase Transformations in Materials (3).
An in-depth analysis of the thermodynamics and kinetics of phase transformation in materials. Topics include: phase equilibria and transformations, thermodynamics applied to processing of materials (metal and alloys, polymers, composites, ceramics, etc.), and kinetics in materials systems including diffusion, nucleation, growth, gas-solid and liquid-solid reactions. This course also highlights a number of commercially-significant applications where phase transformations are important. Prerequisite(s): ME 250 and ME 398; or graduate student status.

ME 781A. Cooperative Education (1).
Academic program that expands a student's learning experiences through paid employment in a supervised educational work setting related to the student's major field of study or career focus. Intended for students who are working full time on their co-op assignment and do not need to be enrolled in any other course. Graded Cr/NCr unless student has received permission before enrolling for course to be used as an elective. Repeatable for credit. Prerequisite(s): approval by the appropriate faculty sponsor.

ME 781P. Cooperative Education (1).
Academic program that expands a student's learning experiences through paid employment in a supervised educational work setting related to the student's major field of study or career focus. Students must enroll concurrently in a minimum of 6 credit hours of coursework including this course in addition to a minimum of 20 hours per week at their co-op assignment. Graded Cr/NCr unless student has received permission before enrolling for course to be used as an elective. Repeatable for credit. Prerequisite(s): approval by the appropriate faculty sponsor.

ME 782. Engineering Applications of Computational Fluid Dynamics and Heat Transfer (3).
Lectures review the basic laws of fluid flow and heat transfer including the Navier-Stokes equations. Laboratory activities include use of a CFD software emphasizing the finite volume method and introducing turbulence modelling. Additional topics include grid generation and benchmarking exercises as well as open-ended projects. Prerequisite(s): ME 325 (or MATH 551) and ME 522 (or AE 424) with a minimum grade of C in each, or the instructor’s consent, or graduate standing.