### Mechanical Engineering Courses

#### Undergraduate

**ME 100 Stress and Applied Elasticity** Three-dimensional theory of elasticity; state of stress, state of strain, elastic stress-strain relations. Applications include elementary three-dimensional problems, plane stress and plane strain, Saint Venant’s long cylinder, beams and plates. Computer-aided design projects. 3 credits. Prerequisite: ESE 101.

**ME 105 Drawing and Sketching for Engineers.** (same as EID 105).

**ME 120 Design Elements** Application of the principles of mechanics to the design of basic machine elements; study of components subjected to static, impact and fatigue loading; influence of stress concentration; deflection of statically determinate and indeterminate structures by the energy method. Design projects apply basic criteria to the design of shafts, springs, screws and various frictional elements; design projects make use of computer, experimental and modeling techniques. 3 credits. Prerequisite: ME 100.

**ME 130 Advanced Thermodynamics** Equations of state; properties of pure substances; ideal and real gas and gas-vapor mixture properties; fundamental process and cycle analysis of ideal and real systems; modern gas and vapor power cycles and refrigeration cycles. Computer applications to problem solving. 3 credits. Prerequisite: ESC 130.

**ME 131 Energetics** (same as EID 131). Current and near-term energy sources, including coal, oil, natural gas, nuclear fission, hydroelectric, oil shale and refuse. Description of contemporary methods of energy conversion including conventional utility power plants and nuclear power plants. Introduction to direct energy conversion; magnetohydrodynamics, fuel cells, thermionic and thermoelectric. Design of the thermodynamic operation of a steam power plant. 3 credits. Prerequisite: ESC 130.

**ME 133 Air-Conditioning, Heating and Refrigeration** (same as EID 133). Introduction to air-conditioning, heating and refrigeration, with emphasis on application of thermodynamics, fluid dynamics, mass transfer and heat transfer, psychrometrics, cycles, load calculation, component and system performance; absorption, refrigeration, heat pumps, solar heating and cooling. 3 credits. Prerequisite: ESC 130, ESC 140.

**ME 140 Gas Dynamics** Integral form of the conservation equations; one-dimensional compressible flows, including isentropic flow, isothermal flow, flow with friction, flow with heat transfer and normal and oblique shock waves; generalized one-dimensional flow. Computer applications and a semester-long design project. 3 credits. Prerequisites: ME 130, ESC 140.

**ME 141 Fundamentals of Aerodynamics** Study of incompressible potential flow around bodies of aerodynamic interest, by the use of equations of motion, method of singularities and conformal transformation. Investigation of experimental results and techniques. Consideration of the effects of viscosity and transition from laminar to turbulent flow. A design-oriented project, usually involving application of computer methods, will be required. 3 credits. Prerequisite: ESC 140.

**ME 142 Heat Transfer: Fundamentals and Design Applications** One-dimensional steady-state conduction. Two-dimensional steady-state conduction and transient conduction; finite-difference equations and computational solution methods. Convection; introduction to laminar and turbulent viscous flows; external and internal forced convection problems, including exact and numerical solution techniques; free convection. Introduction to radiation heat transfer and multimode problems. Open-ended design projects will include application to fins, heat exchangers, tube banks and radiation enclosures and will make use of computer-aided design techniques. 3 credits. Prerequisite: ESC 140.

**ME 144 Fluid Mechanics** Singularity and conformal transformation; deflection of statically determinate and indeterminate structures subjected to static, impact and fatigue loading; influence of stress concentration; design of basic machine elements; study of components subjected to static, impact and fatigue loading; influence of stress concentration; deflection of statically determinate and indeterminate structures by the energy method. Design projects apply basic criteria to the design of shafts, springs, screws and various frictional elements; design projects make use of computer, experimental and modeling techniques. 3 credits. Prerequisite: ME 100.

**ME 150 Design and Prototyping** A mechanical engineering hands-on workshop geared towards the understanding and practice of basic engineering design and fabrication techniques. Topics include hand tools, simple machining, mold making, casting, materials, fasteners, adhesives, and finishes. 3-D digitizing, rapid prototyping and computer interfacing will also be presented. Team projects will familiarize the students with typical tools and processes employed in realizing a design concept, from sketch to functional prototype. Each student will participate in and contribute to the team-learning and creation process. 2 credits. Prerequisite: EID 101.

**ME 151 Feedback Control Systems** Modeling and representation of dynamic physical systems: transfer functions, block diagrams, state equations, and transient response. Principles of feedback control and linear analysis including root locus and frequency response methods. Practical applications and computer simulations using MATLAB. Discussions of ethics will be integrated into the curriculum. 3 credits. Prerequisite: Ma 240, ECE 121.

**ME 153 Mechatronics** (same as EID 153). Topics include computer architecture, PIC processor overview, dynamic modeling, sensors, data acquisition, digital PID control theory, and utilization of assembly language to code the controller. Students will design, build and test a controller board and present a final prototype of a control system. Engineering economics will be introduced and integrated into the final project. Prerequisite: ME 151 or ECE 121 or CHE 152.

**ME 155 Design and Prototyping** A mechanical engineering hands-on workshop geared towards the understanding and practice of basic engineering design and fabrication techniques. Topics include hand tools, simple machining, mold making, casting, materials, fasteners, adhesives, and finishes. 3-D digitizing, rapid prototyping and computer interfacing will also be presented. Team projects will familiarize the students with typical tools and processes employed in realizing a design concept, from sketch to functional prototype. Each student will participate in and contribute to the team-learning and creation process. 2 credits. Prerequisite: EID 101.
ME 162 Experimentation
Methods and procedures in laboratory investigations involving applications of fluid mechanics and thermodynamics. Experimental work will involve performance prediction and evaluation of important types of mechanical engineering devices. Emphasis will be placed on written and oral reports and the handling of data by computer methods.
2 credits. Prerequisite: ME 161.

ME 163 Mechanical Engineering Projects
Original investigations, involving design and experimental work which allow the application of engineering sciences to the analysis and synthesis of devices or systems and permit the deepening of experience in engineering decision making. Projects are carried out in small groups and are supervised by the instructor in accordance with professional practice.
3 credits. Prerequisite: permission of instructor.

ME 164 Capstone Senior ME Design
The application of open-ended design work to the synthesis of engineering devices and systems for the satisfaction of a specified need. Consideration of market requirements, production costs, safety and esthetics. Projects are carried out in small groups and are supervised by the instructor in accordance with professional practice. The goal of the course is to create a working design, clearly defined in drawings and specifications.
3 credits. Prerequisite or co-requisite: ME 163.

ME 300 Space Dynamics
Fundamental principles of advanced dynamics; kinematics, transformation or coordinates; particle and rigid body dynamics. Application to space problems; satellite orbits; gyro-dynamics; space vehicle motion; performance and optimization. Generalized theories of mechanics; virtual work, D’Alembert’s principle; Lagrange’s equation; Hamilton’s principle.
3 credits. Prerequisite: ESC 100.

ME 312 Manufacture Engineering
(same as EID 312). Study of metal processing theory and application with emphasis on casting, machining, and metal deformation processes; plastic forming; special processing techniques; work-holder design principles. Specific areas studied include stages of processing, mathematical modeling of processes, equipment determination, relationship of plant layout, tooling, metrology, and product design to product cost.
3 credits. Prerequisite: EID 101.

ME 313 Science of Materials for Engineering Design
(same as EID 313). This course is intended to give the student the tools with which to design with materials: to choose an existing material for a new application or design the ideal material to replace one in use. The materials studied cover the full range: metals, ceramics, glasses, polymers, composite materials and wood. Topics include phase diagrams and phase transformations, structure and strength, normal use and failure, all with an eye on design.
3 credits. Prerequisite: ESC 110 or ESC 110.1.

ME 314 (same as EID 314), 3 credits. Prerequisites: ESC 101, ESC 110 or ESC 110.1.

ME 320 Mechanical Design
Mechanical design of basic transmission elements; design optimization by blending fundamental principles and engineering judgment; design criteria for the various frictional machine elements. Design projects provide authentic involvement in problems from industry; design projects make use of computer, experimental and modeling techniques.
3 credits. Prerequisite: ME 120.

ME 321 Engineering Kinematics
Study of motion conversion through various types of mechanical components, using analytical and graphical techniques. Velocity and acceleration analysis; special kinematic devices, synthesis of mechanisms; linkage design. Theory applied to creative project assignments.
3 credits. Prerequisite: ESC 100.

ME 322 Dynamics of Machines
Application of mechanics to rigid bodies as found in machines and machine elements. Dynamics of machines as influenced by the kinematics of the motion, externally applied forces and self-generating inertial forces.
3 credits. Prerequisite: ME 101.

ME 330 Advanced Engine Concepts
Development of energy efficient, high-output, cleaner engine systems. Broad analytical and experimental review of the governing parameters involved in engine design and optimization. Topics include thermodynamics, fluid mechanics, heat transfer, combustion, emissions, thermochemistry, dynamic and static loading, and fuel efficiency, as they apply to different engine cycles and types. Research examples from industry, government, and academia are reviewed. Stationary and mobile applications, with particular emphasis on automotive engine design are analyzed. Hands-on learning skills are developed through computational and experimental assignments.
3 credits. Prerequisite: ME 142.

ME 334 Combustion
3 credits. Prerequisite: ESC 141 or ME 142.

ME 340 Advanced Aerodynamics
Study of ideal compressible flow around aerodynamic bodies by the use of linearized subsonic and supersonic theory. Investigation of computational techniques and experimental methods and results. Consideration of real gas and viscous effects and hypersonic flow.
3 credits. Prerequisites: ESC 130 and ME 141.

ME 343 Fluid Machinery
The application of fluid mechanics and thermodynamics to the analysis and design of turbomachines. Topics to be studied include theory and three-dimensional flows. Both axial and radial flow fans, blowers, compressors, pumps and turbines will be considered as well as special topics in turbo-machinery. A design project, usually involving application of computer methods, will be required.
3 credits. Prerequisites: ESC 130, ESC 140.

ME 352 Advanced Control Theory
(same as EID 352). Tools and methods of control system design and compensation; simulation, specifications, frequency domain techniques, state variable feedback, sensitivity analysis. Specific topics covered are controllability, observability, Lyapunov stability, pole placement technique, full order observers, reduced order observers and output feedback. Emphasis will be placed on modern control theory. Group design project to build working prototype. Both engineering economics and ethics will be addressed when presenting the final working prototype.
3 credits. Prerequisite: ME 151 or ECE 121 or CHE 152.

ME 353 Transducers, Sensors and Computer Interfacing
(same as EID 353). Transducers and sensors are widely used in engineering and scientific research and as an integral part of products and automated systems. Students will be introduced to numerous available techniques for sensing displacement, force, pressure, acceleration, temperature, radiation and other physical parameters; digital computation and digital transducers; computer interfacing such as analog signal conversion, signal processing, interface components, communication; software systems such as programming real-time systems and real-time operating systems. The instructor will present case histories of several industrial instrumentation and sensing systems. Projects provide authentic involvement in problems from industry that require computer interfacing and experimental techniques.
3 credits. Prerequisite: permission of instructor.

ME 356 Digital Control and Nonlinear Control
(same as EID 356). Introduction to digital control systems, z-transformations, discrete equivalents to continuous transfer functions, design of digital controllers, non-linear control theory. Laboratory experiments will be performed which will include control of the speed of a motor through computer programming.
3 credits. Prerequisite: ME 151.
ME 363-364 Selected Topics in Mechanical Engineering
This course will deal with current technological developments in various fields of mechanical engineering. Projects and design will be emphasized.
3 credits each. Prerequisite: ME faculty permission.

ME 365 Mechanical Engineering Research Problem
An elective course available to qualified students. Students may elect to consult with an ME faculty member and apply to carry out independent research on problems of mutual interest in theoretical or applied mechanical engineering. 3 credits. Prerequisite: ME faculty permission and senior standing. May be repeated.

Graduate

ME 401 Advanced Mechanical Vibrations
Study of the transition from discrete to continuous systems; analytical and numerical methods as applied to axial and transverse systems; formulation of complex dynamic systems by the energy method; introduction to nonlinear and random vibrations. System design augmented by Holzer and Matrix interaction on the computer; computer-aided design projects directly from industry.
3 credits. Prerequisite: ME 101.

ME 402 Advanced Stress Analysis
Elements of stress and deformation analysis. Numerical and analytical techniques include finite difference, relaxation, finite element, complex variables and energy and variational methods. Applications include torsion, two-dimensional problems, bending of bars, elastic stability, wave propagation, thin plates and shells and curved beams and plates.
3 credits. Prerequisite: ME 100.

ME 403 Advanced Engineering Dynamics
Elements of classical dynamics: kinematics, kinetics, work and energy, impulse and momentum, vibration. Motion of a system of particles and rigid bodies. Lagrangian dynamics.
3 credits. Prerequisite: ME 101.

ME 410 Materials and Manufacturing Process
Same as EID 410. In manufacturing operations, materials are subjected to large forces for producing useful shapes. This course attempts to establish an understanding of the behavior of materials in response to such forces. Topics covered will include elastic behavior, plasticity, strengthening mechanisms, basic manufacturing processes and testing. Vital aspects of the continuum behavioral response of materials to manufacturing processes will be covered emphasizing the mechanical and metallurgical factors that control the processes.
3 credits.

ME 412 Autonomous Mobile Robots
This course introduces basic concepts, technologies, and limitations of autonomous mobile robots. Topics include digital and analog I/O, tactile sensing, IR sensing and range finding, light sensing, sonar, magnetic field sensing, encoders, DC motor actuators, servo motor actuators, high-level microprocessor control, low-level microprocessor control, power management, and prototyping. Students will form teams to design and build autonomous mobile robots configured to compete with each other in a singles-match game, or to perform a team-oriented task.
3 credits. Prerequisite: ME 153 or ECE 151.

ME 420 Axiomatic Design
Same as EID 420.
3 credits. Prerequisite: permission of instructor.

ME 421 Rehabilitation Engineering
Same as EID 421.
3 credits. Prerequisite: permission of instructor.

ME 423 Measurement of Human Performance
Same as EID 423.
3 credits. Prerequisite: permission of instructor.

ME 425 Product Design I
Same as EID 425.
3 credits.

ME 426 Product Design II
Continuation of ME/ID 425.
3 credits. Prerequisite: ME/ID 425.

ME 430 Thermodynamics of Special Systems
Same as EID 430 and ChE 430.
3 credits. Prerequisite: ME 130.

ME 431 Heat Convection
Conservation equations; forced convection in laminar and turbulent flows; natural convection; combined natural and forced convection; heat transfer at high velocities, special heat transfer problems.
3 credits. Prerequisite: ESC 141.

ME 432 Heat Conduction and Radiation
Theory of heat conduction in isotropic and anisotropic solids; analytical, graphical and numerical solutions to steady- and non-steady-state heat conduction equations. Thermal radiation in absorbing and non-absorbing media. Application to selected problems involving combined energy transport mechanisms and to heat transfer problems of current interest.
3 credits. Prerequisite: ESC 141.

ME 434 Special Topics In Combustion
Same as ChE 434. Analysis of diffusion and premixed flame processes, including droplet and particle flames, combustion in sprays, chemical reactions in boundary layers, combustion instability in liquid and solid rocket engines and gas burner flames. Consideration of ignition and quenching processes and flammability limits.
3 credits. Prerequisite: ME 334.

ME 440 Advanced Fluid Mechanics
Same as EID 440 and ChE 440.
3 credits. Prerequisites: ESC 140 and permission of instructor.

ME 451 Introduction to Applied Optimal Control Theory and Design
An introduction to the concepts and techniques utilized in the analysis and design of optimal (deterministic) control systems. Topics include a review of state-space control systems concepts; reduced order observers and state-feedback controllers; basic theory of linear quadratic optimal control; standard regulator problem; optimal tracking systems; introduction to the calculus of variations and functional optimization; utilization of computer-aided optimal control systems design software such as MATLAB. Techniques developed will be applied, in the form of student design projects, to a variety of challenging control systems design problems.
3 credits. Prerequisite: ME 151 or ECE 121 or ChE 152.

ME 452 Design/Computer-Aided Manufacturing (CAD/CAM)
Same as EID 453. Computer design aids, languages, databases, and data structures; geometric modeling; rapid prototyping; design verification, simulation, and testing; investigation of commercial CAD/CAM packages. Student projects include geometric modeling with commercial CAD/CAM packages, team-based product design, and programming of basic CAD applications. Students are grouped into design teams and are expected to work on a term project starting with specifications, carrying out the full work and documentation of actual design projects.
3 credits. Prerequisite: ECE 161.

ME 455 Computer-Aided Design
Same as EID 455. Introduction to linear and nonlinear estimation methods with emphasis on both theory and implementation. Batch and sequential strategies, real-time and post-experiment estimation are covered. Includes both parameter estimation and state estimation. Topics covered are a review of probability and optimization, parameter estimation (linear and nonlinear least squares), minimal variance and maximum likelihood estimation, system identification and estimation, Kalman filtering, smoothing, covariance propagation for continuous and discrete systems as well as linear and nonlinear, real-time and post-processing and minimum model error estimation. Students will work on realistic problems such as global positioning using geosynchronous satellites. MATLAB software used extensively.
3 credits. Prerequisite: ME 151 or ECE 121 or ChE 152.

ME 457 – Optimization Techniques
Same as EID 457. Optimization techniques with applications in various aspects of engineering design. Concepts of design variables, constraints, objective functions, penalty functions, Lagrange multipliers. Techniques for solving constrained and unconstrained optimization problems; classical approaches, steepest descent, conjugate directions, conjugate gradient, controlled random searches, etc. Discussion of generalized reduced gradient, sequential linear programming, and recursive quadratic programming strategies. Special topics will be discussed such as optimum
sensitivity analysis, multilevel optimization, and integer programming. Computer implementation of optimization schemes. Applications and examples in the design of engineering components and systems. A design project will be assigned that will require the use of several optimization schemes. 3 credits. Prerequisite: Ma 223.

**ME 458 Industrial Robots** (same as EID 458). Basic concepts, techniques, and limitations of modern industrial robots; industrial automation; robot programming languages; definition and description of a robot work space; application of transform and operator matrices in industrial robotics. Student projects include computer programming of forward and inverse kinematics, and application programming with an industrial robot. 3 credits. Prerequisite: EID 151.

**ME 464 Computer-Integrated Manufacturing** (same as EID 464). Fundamentals of computer-aided design, analysis, and manufacturing; geometric modeling, IGES, PDES, and STEP; rapid prototyping; mechanism simulation and finite element analysis; CNC part programming and machining; group technology and process planning. Student projects emphasize concurrent engineering and teamwork. 3 credits. Prerequisite: ME 312.

**ME 470 Microelectromechanical systems (MEMS)** This course covers the fundamental and advanced aspects of MEMS. Topics include introduction to MEMS, materials and fabrication processes, sensors and actuators, microfluidics, scaling principles, device concepts and system design. MEMS processing simulation and modeling, testing and packaging of MEMS will also be presented. Exposure to basic MEMS processing and clean-room protocol will be included. 3 credits. Prerequisite: ESC 110.

**ME 493-494 Selected Advanced Topics in Mechanical Engineering** These courses will deal with current advanced technological developments in various fields of mechanical engineering. Projects and design will be emphasized. 3 credits. Prerequisite: ME faculty permission and graduate standing.

**ME 499 Thesis/Project** Master’s candidates are required to conduct, under the guidance of a faculty advisor, an original investigation of a problem in mechanical engineering, individually or in a group and to submit a written thesis describing the results of the work. 6 credits for full year.