ME 310 Engineering Materials credit: 4 Hours.
Structures of polymers, metals, and ceramics as the basis for their mechanical behavior. Manipulation of structure through such processes as heat treatment and solidification. Mechanisms of material failure in service (yielding, fracture, fatigue, creep, corrosion, and wear) and simple design techniques to avoid these failures. Strategies for materials selection in design. Credit is not given for both ME 330 and either CEE 300 or MSE 280. Prerequisite: CHEM 102 and TAM 251.

ME 340 Dynamics of Mechanical Systems credit: 3.5 Hours.
Dynamic modeling of mechanical components and systems; time-domain and frequency-domain analyses of linear time-invariant systems; multi-degree-of-freedom systems; linearization of nonlinear systems. Credit is not given for both ME 340 and either GE 320 or AE 353. Prerequisite: MATH 285 and TAM 212; credit or concurrent registration in ECE 205 and MATH 415.

ME 351 Analysis of Mfg Processes credit: 3 Hours.
Mechanistic and empirical modeling of manufacturing processes including metal cutting theory, casting analysis, forging analysis, sheet metal forming, plastics molding, welding and mechanical joining assembly analysis. Also, hands-on exposure to manufacturing processes, CAD/CAM software (MasterCam), 5 axis machining (ShopBot), Wire EDM machining, statistical process control (SPC), and geometric dimensioning and tolerancing (GD&T) metrology principles using CMM. Prerequisite: ME 270.

ME 350 Signal Processing credit: 3.5 Hours.
Basic electromechanical techniques used in modern instrumentation and control systems. Use of transducers and actuators. Signal conditioning, grounding, and shielding. Analog and digital signal processing and feedback control methods with emphasis on frequency domain techniques. Frequency response of continuous and discrete systems. Credit is not given for both ME 360 and ABE 425. Prerequisite: ME 340.

ME 340 Mechanical Design I credit: 3 Hours.
Kinematics and dynamics of machine, including analytical kinematics, force analysis, cam design and balancing. Application of elementary mechanics of solids to analyze and size machine components for stress and deflection. Finite-element analysis with emphasis on beam and plate models. Prerequisite: ME 170, TAM 212, and TAM 251.

ME 371 Mechanical Design II credit: 3 Hours.
Design and analysis of machinery for load-bearing and power transmission. Consideration of material failure modes, including yielding, fracture, fatigue, and creep. Design and selection of machine elements: bolts, springs, rolling-element bearings, fluid-film lubrication, and power transmissions, including gears and friction drives. Prerequisite: ME 330 and ME 370.

ME 400 Energy Conversion Systems credit: 3 or 4 Hours.
Processes and systems for energy conversion, including power and refrigeration cycles, air conditioning, thermoelectrics and fuel cells; ideal-gas mixtures and psychrometrics. 3 undergraduate hours. 4 graduate hours. Prerequisite: ME 300.

ME 401 Refrigeration and Cryogenics credit: 3 or 4 Hours.
Theory of operation and design of equipment for production of low temperatures, from below ambient to near absolute zero; industrial, consumer, aerospace, medical, and research applications. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: ME 300, ME 310, and ME 320.
ME 402 Design of Thermal Systems  
**credit: 3 or 4 Hours.**  
Selection of components in fluid- and energy-processing systems to meet system-performance requirements; computer-aided design; system simulation; optimization techniques; investment economics and statistical combinations of operating conditions. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: Credit or concurrent registration in ME 320.

ME 403 Internal Combustion Engines  
**credit: 3 or 4 Hours.**  
Theory and analysis of reciprocating internal-combustion engines; fuels, carburetion, combustion, exhaust emissions, detonation, fuel injection, and factors affecting performance; laboratory work on variables that affect performance. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: Credit or concurrent registration in ME 400 or ABE 466.

ME 404 Intermediate Thermodynamics  
**credit: 4 Hours.**  
Classical thermodynamics, including the Tds equations and the Maxwell relations; development of thermodynamic property relations, behavior of real gases, thermodynamics of mixtures, phase equilibrium and chemical reactions and equilibrium with an emphasis on combustion reactions; statistical thermodynamics including the effect of molecular and atomic structure, statistical concepts and distributions, calculation of thermodynamic properties of gas-phase atoms and molecules, kinetic theory of gases, and vibrations in crystals and the electron gas in metals; selected applications. 4 undergraduate hours. 4 graduate hours. Credit is not given for both ME 404 and any of PHYS 427, CHEM 442, or CHEM 444. Prerequisite: ME 300.

ME 410 Intermediate Gas Dynamics  
**credit: 3 or 4 Hours.**  
Solution of internal compressible-flow problems by one-dimensional techniques, both steady and unsteady; flows with smooth and abrupt area change, with friction, with heat addition, and with mass addition; flows with weak and strong waves, multiple confined streams, and shock waves. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: ME 300 and ME 310; or one of AE 311, TAM 335.

ME 411 Viscous Flow & Heat Transfer  
**credit: 4 Hours.**  
Same as AE 412. See AE 412.

ME 412 Numerical Thermo-Fluid Mechs  
**credit: 2 to 4 Hours.**  
Numerical techniques for solving the equations governing conduction and convective heat transfer in steady and unsteady fluid flows: finite-difference and finite-volume techniques, basic algorithms, and applications to real-world fluid-flow and heat-transfer problems. Same as CSE 412. 2 or 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: ME 310 and ME 320.

ME 420 Intermediate Heat Transfer  
**credit: 4 Hours.**  
Conduction heat transfer, radiation heat transfer, mass transfer, phase change, heat exchangers; numerical methods. 4 undergraduate hours. 4 graduate hours. Prerequisite: ME 310 and ME 320.

ME 430 Failure of Engrg Materials  
**credit: 3 or 4 Hours.**  
Material anisotropy and elasto-plastic properties at the crystal level; microstructural basis for fatigue, fracture, and creep in metals, polymers, and ceramics; failure mechanisms and toughening in composites; structure and behavior of metal-matrix composites, ceramic-matrix composites, and polymer composites. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: ME 330.

ME 431 Mechanical Component Failure  
**credit: 3 or 4 Hours.**  
Relationship of materials and mechanics concepts to the design of structures and components: elasticity, plasticity, thermal loading, creep, fatigue, fracture, and residual-life assessments as they relate to materials selection and design. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: ME 330 and ME 371; Recommended: ME 430.

ME 432 Fundamentals of Photovoltaics  
**credit: 3 or 4 Hours.**  
In this course, we will develop a fundamental understanding of how solar cells convert light to electricity, how solar cells are made, how solar cell performance is evaluated, and the photovoltaic technologies that are currently on the market and/or under development. Using thermodynamics, materials physics, and engineering analysis we will assess and critique the potential and drawbacks of modern photovoltaic technologies, including single- and multi-crystalline silicon, tandem cells, CdTe, CIGS, PVT, bulk heterojunctions (organic), Graetzel cells, nanostructure-based, and third generation PV. 3 undergraduate hours. 4 graduate hours. Approved for Letter and S/U grading. Prerequisite: PHYS 212 and ME 330 or equivalent.

ME 440 Kinem & Dynamics of Mech Syst  
**credit: 3 or 4 Hours.**  
Kinematics and dynamics of constrained rigid-body mechanical systems; use of modern computer-based analysis software packages. 3 undergraduate hours. 4 graduate hours. Prerequisite: ME 370.

ME 445 Introduction to Robotics  
**credit: 4 Hours.**  
Same as AE 482 and ECE 470. See ECE 470.

ME 446 Robot Dynamics and Control  
**credit: 4 Hours.**  
Same as ECE 489 and SE 422. See SE 422.

ME 450 Modeling Materials Processing  
**credit: 3 Hours.**  
Manufacturing processes for metals and polymers; creation of process models based on momentum, heat, and mass transfer; model simplification by estimation and scaling; applications to casting, microstructure evolution, polymer molding and extrusion, and welding. 3 undergraduate hours. 3 graduate hours. Prerequisite: ME 320 and ME 330.

ME 451 Computer-Aided Mfg Systems  
**credit: 3 or 4 Hours.**  
The application of computer technology and operations research to manufacturing systems. Use of microprocessors for direct numeric control of machine tools, adaptive control and optimization, and integrated manufacturing systems. Applications of industrial robots. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: ME 270.

ME 452 Num Control of Mfg Processes  
**credit: 3 or 4 Hours.**  
Numerical control systems, manufacturing processes, principles and practices basic to numerical control, and programming methodology for numerical control. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 101 and ME 270.

ME 455 Micromanufacturing Process & Automation  
**credit: 3 or 4 Hours.**  
Scaling laws in miniaturization, Micro-machine tools design and characterization, Micromanufacturing process modeling, simulation and automation, Micro-metrology and Micro-assembly systems. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: ME 270 or equivalent or consent of instructor.

ME 460 Industrial Control Systems  
**credit: 4 Hours.**  
Industrial control techniques; case studies of industrial systems; design, selection, and maintenance of industrial control systems, including electromechanical, pneumatic, thermal, and hydraulic systems. 4 undergraduate hours. 4 graduate hours. Credit is not given for both ME 460 and ECE 486. Prerequisite: ME 340 and ME 360.

ME 461 Computer Cntrl of Mech Systems  
**credit: 3 or 4 Hours.**  
Microcomputer control of thermal and mechanical systems: sensors and transducers, signal transmission and conversion, and regulator actuation. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: ME 360 or ABE 425.

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Information listed in this catalog is current as of 04/2018
ME 470  Senior Design Project  credit: 3 Hours.
Solution of a real-world design problem: development, evaluation, and recommendation of alternative solutions subject to realistic constraints that include most of the following considerations: economics, environment, sustainability, manufacturability, ethics, health and safety, society, and politics. 3 undergraduate hours. No graduate credit. Departmental approval required. Prerequisite: Concurrent enrollment in no more than two required ME courses; completion of all required courses. This course satisfies the General Education Criteria for: Advanced Composition

ME 471  Finite Element Analysis  credit: 3 or 4 Hours.
The finite element method and its application to engineering problems: truss and frame structures, heat conduction, and linear elasticity; use of application software; overview of advanced topics such as structural dynamics, fluid flow, and nonlinear structural analysis. Same as AE 420 and CSE 451. 3 or 4 undergraduate hours. 3 or 4 graduate hours. Credit is not given for both ME 471 and CEE 470. Prerequisite: CS 101 and ME 371 or TAM 470. Alternatively, AE 370 for AE students.

ME 472  Introduction to Tribology  credit: 3 or 4 Hours.
Friction, wear, and lubrication; engineering surfaces; surface properties and surface topography; Hertzian contacts and contact of rough surfaces; friction of surfaces in contact; wear and surface failures; boundary lubrication; fluid properties; hydrodynamic lubrication; elastohydrodynamic lubrication; bearing selection; introductory micro- and nanobiology. 3 undergraduate hours. 3 or 4 graduate hours.

ME 481  Whole-Body Musculoskeletal Biomech  credit: 3 or 4 Hours.
Exploration of the human musculoskeletal system with an emphasis on the whole-body or organism level; modeling and analysis techniques for examining human movement, such as rigid-body modeling techniques, forward and inverse dynamics, and Lagrangian mechanics; examination of current topics, such as orthopedic biomechanics, prosthetics and orthotics, postural control, and locomotion; use of computerized motion-capture equipment and software to examine, simulate, and analyze human movement. Same as BIOE 481. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: TAM 212 and TAM 251.

ME 482  Musculoskeletal Tissue Mechanics  credit: 3 or 4 Hours.
Composition-structure-function relationships for musculoskeletal tissues, including bone, tendon, ligament, cartilage, and muscle; hierarchical structure of tissues from the macro- to nano-scales; relation of composition to mechanical properties of health and diseased tissue; experimental methods used to obtain mechanical properties. Same as BIOE 482. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: TAM 251.

ME 483  Mechanobiology  credit: 4 Hours.
Integrative approach to mechanobiology; mechanics of cell adhesion; cytoskeletal structure and mechanics; mechanotransduction; mechanics of cell proliferation, apoptosis, cancer cells, and stem cells; aging; critical issues facing the mechanobiological sciences. 4 undergraduate hours. 4 graduate hours. Prerequisite: CHEM 103 and TAM 251.

ME 485  MEMS Devices & Systems  credit: 3 Hours.
Same as ECE 485. See ECE 485.

ME 487  MEMS-NEMS Theory & Fabrication  credit: 4 Hours.
Physical and chemical theory, design, and hands-on fabrication of micro- and nano-electromechanical systems (MEMS and NEMS); cleanroom fabrication theory, including general cleanroom safety, lithography, additive and subtractive processes, bulk and surface micromachining, deep reactive ion etching (DRIE), lithographic Galvanomformung Abformung (LIGA), packaging, scaling, actuators, and micro-nanofluids; fabrication of two take-home devices, such as piezoresistive sensors and microfluidic logic chips, that demonstrate advanced fabrication processing. 4 undergraduate hours. 4 graduate hours. Prerequisite: PHYS 212.

ME 496  Honors Project  credit: 1 to 4 Hours.
Special project or reading course for James Scholars in engineering. 1 to 4 undergraduate hours. No graduate credit. May be repeated. Prerequisite: Consent of instructor.

ME 497  Independent Study  credit: 1 to 3 Hours.
Independent study of advanced problems related to mechanical engineering. 1 to 3 undergraduate hours. No graduate credit. May be repeated in separate terms to a maximum of 6 hours, as topics vary. Prerequisite: Consent of Instructor. Students with Junior or Senior standing.

ME 498  Special Topics  credit: 0 to 4 Hours.
Subject offerings of new and developing areas of knowledge in mechanical engineering intended to augment the existing curriculum. See Class Schedule or departmental course information for topics and prerequisites. 0 to 4 undergraduate hours. 0 to 4 graduate hours. May be repeated in the same or separate terms if topics vary to a maximum of 9 hours.

ME 501  Combustion Fundamentals  credit: 4 Hours.
Fundamentals of kinetic theory, transport phenomena, chemical equilibria, and reaction kinetics; flames, their gross properties, structure, and gas dynamics including oscillatory and turbulent burning; solid and liquid propellant combustion; one-dimensional detonation theory including structure and initiation; three-dimensional and other complex detonation waves; supersonic burning. Same as AE 538. Prerequisite: AE 311 or ME 410.

ME 502  Thermal Systems  credit: 4 Hours.
Steady-state simulation and optimization of thermal systems, dynamic performance, and probabilities in system design. Prerequisite: ME 402.

ME 503  Design of IC Engines  credit: 4 Hours.
Design of internal combustion engines, including gas forces, inertia loads, bearing analysis, torsional vibration, balance, lubrication, valve and cam design, and stress analysis of major engine components. Prerequisite: ME 403.

ME 504  Multiphase Systems & Processes  credit: 4 Hours.
Dynamics and thermodynamics of multiphase and multicomponent systems with special relevance to air-pollution control and energy conversion; relaxation phenomena; general motion of systems of disparate elemental masses; diffusion in gravitational and electric fields, and boundary-layer motion with mass transport; dispersion and collection of particulate matter; transport with surface reactions. Prerequisite: ME 404.

ME 510  Advanced Gas Dynamics  credit: 4 Hours.
Theoretical gas dynamics; fundamental laws and basic equations for subsonic, transonic, and supersonic steady and unsteady flow processes. Same as AE 510. Prerequisite: ME 410.
ME 520 Heat Conduction credit: 4 Hours.
Fundamentals of heat conduction in isotropic and anisotropic materials; methods of solution to steady and transient heat conduction problems in one, two, and three dimensions; internal heat sources; periodic flow of heat; problems involving phase change; approximate analytical techniques; numerical methods; study of current articles on the subject. Prerequisite: ME 420.

ME 521 Convective Heat Transfer credit: 4 Hours.
Fundamentals of convective heat transfer; calculation of heat transfer within ducts and over submerged objects for laminar and turbulent flow; natural convection; film condensation and boiling; liquid metals. Prerequisite: ME 411.

ME 522 Thermal Radiation credit: 4 Hours.
Fundamentals of radiant-energy transport in absorbing and nonabsorbing media; pyrometry; applications to selected problems involving combined energy-transport mechanisms. Prerequisite: ME 420.

ME 523 Nanoscale Energy Transport credit: 4 Hours.
An advanced treatment of diverse transport phenomena at the nanometer scale involving solids, liquids and gases emphasizing common features in transport by molecules, electrons, phonons, photons, and other quasi-particles of interest, oriented toward applied research in the areas of nanoscale heat transfer and nanoscale energy conversion. Topics include intermolecular forces at surfaces and in the bulk, momentum and species transport in microfluidics, linear response theory, free molecular flow in gases, electron and phonon transport in crystals, Boltzmann equation and its moments, ballistic and diffusive transport, thermoelectric energy conversion, interfacial transport, energy transport in nanostructures and radiative transport in the near-field. Approved for letter and S/U grading.

ME 530 Fatigue Analysis credit: 4 Hours.
Fatigue analysis methods for the design of structures and components: stress-life, strain-life, and crack-propagation approaches; multiaxial and high-temperature fatigue; interrelationship among material properties, geometry, and design methodology appropriate for a wide range of mechanical engineering components. Prerequisite: ME 430.

ME 531 Inelastic Design Methods credit: 4 Hours.
Material deformation under combined mechanical and thermal loading; constitutive equations and their application in engineering design and in inelastic finite element methods; material and structural degradation under fatigue and creep conditions. Prerequisite: ME 471 and ME 430.

ME 532 Fracture Resistant Design credit: 4 Hours.
Application of fracture mechanics and microstructural behavior to materials selection for design; practical approximation of linear and inelastic fracture parameters for evaluation of complex components; destructive and nondestructive tests for control of toughness in manufacture; residual life assessment involving time-dependent fracture (creep, fatigue, stress, corrosion); case studies; design project. Prerequisite: ME 430.

ME 533 Physical Basis for Plasticity credit: 4 Hours.
Physical and mathematical foundation for plasticity in crystalline materials, with application to deformation processes. Metal forming; deformation processes in other materials, such as slip in geological materials and polymers; rate dependence of plastic flow, with underlying physical mechanisms; kinetics of dislocation motion, mechanisms of work hardening, and crystallographic texture; theoretical framework for modeling the constitutive response of rate-dependent materials undergoing crystallographic slip, and allied computational procedures. Prerequisite: TAM 445.

ME 540 Control System Theory & Design credit: 4 Hours.
Same as ECE 515. See ECE 515.

ME 541 Control of Machine Systems credit: 4 Hours.
Modeling machining processes and machine tools. Mechanistic modeling of machining processes, machine-tool errors, characterization of machined surfaces, machine-tool system dynamics and stability, and topics in motion control. 4 graduate hours. No professional credit. Prerequisite: ME 340 and ME 270.

ME 542 Dynamic System Reliability credit: 4 Hours.
Same as ECE 554. See ECE 554.

ME 546 Analysis of Nonlinear Systems credit: 4 Hours.
Same as ECE 528 and SE 520. See ECE 528.

ME 550 Solidification Processing credit: 4 Hours.
Principles of control of structure, properties, and shape in processes involving liquid-solid transformations; stresses, heat flow, mass transport, solute redistribution, and nucleation and growth kinetics; relationship between process variables and structures and properties in the resultant material; examples are drawn from existing commercial and new developing processes. Prerequisite: ME 450.

ME 554 Computational Process Modeling credit: 4 Hours.
Development and application of computer models to solve practical problems involving fluid flow, heat transfer, and deformation phenomena. Advanced topics in computational methods for materials process modeling; case studies. Same as CSE 561. Prerequisite: ME 412 or ME 471; ME 450.

ME 561 Convex Methods in Control credit: 4 Hours.
Use of convex optimization in analysis and control of dynamical systems; robust control methods and the use of semidefinite programming; linear matrix inequalities, operator theory, model reduction, H-2 and H-infinity optimal control, S-procedure and integral quadratic constraints, structured singular value and mu-synthesis, and Markovian jump systems; applications in control design. Prerequisite: ECE 515.

ME 562 Robust Adaptive Control credit: 4 Hours.
Mathematical foundation for synthesis and analysis of adaptive control systems: Lyapunov stability theory; methods of direct and indirect model reference adaptive control; recent methods, such as L1 adaptive control, that enable adaptive control with desired transient and steady-stage performance specifications. Prerequisite: Any of ECE 486, ECE 515, ECE 528, GE 424, ME 460.

ME 570 Nonlinear Solid Mech Design credit: 4 Hours.
Optimality conditions; finite element methods; design sensitivity analysis; nonlinear analysis; transient analysis; thermo-mechanical solid mechanics. Same as AE 524. 4 graduate hours. No professional credit. Prerequisite: One of AE 420, CEE 470, ME 471, TAM 470; TAM 445, TAM 551.

ME 586 Mechanics of MEMS credit: 4 Hours.
Mechanics and dynamics of microelectromechanical systems (MEMS); scaling laws in electrostatics, magnetics, and fluids; analytical models for thin-film growth and etching; effect of surface tension in small dimensions in relations to stability of MEMS during web fabrication; size effects on mechanical properties of MEMS materials; equations of motion for MEMS, involving coupled elastic and electric fields that give rise to nonlinear dynamical behavior; Mathieu behavior and chaotic systems. Prerequisite: ME 485.

ME 590 Seminar credit: 1 Hour.
Presentation and discussion of significant developments in mechanical engineering. Approved for S/U grading only. May be repeated.
ME 591  Interest Group Seminar  credit: 1 Hour.
Seminars on current topics in mechanical science and engineering. May be repeated in the same term if topics vary. May be repeated in separate terms.

ME 597  Independent Study  credit: 1 to 4 Hours.
Independent study of advanced problems related to mechanical engineering. May be repeated in the same term or in separate terms if topics vary to a maximum of 12 hours. Prerequisite: Consent of instructor.

ME 598  Special Topics  credit: 1 to 4 Hours.
Subject offerings of new and developing areas of knowledge in mechanical engineering intended to augment the existing curriculum. See Class Schedule or departmental course information for topics and prerequisites. May be repeated in the same or separate terms if topics vary.

ME 599  Thesis Research  credit: 0 to 16 Hours.
Approved for S/U grading only. May be repeated.