M E - Mechanical Engineering

Mechanical Engineering: M E

Lower-Division Courses

M E 302. Introduction to Engineering Design and Graphics.

Introduction to mechanical engineering education and practice through lectures and laboratory experiences. Graphics and modeling fundamentals for engineering design: freehand sketching, computer modeling of solid geometry, and generation of engineering drawings. Introduction to reverse engineering, computer-aided design, rapid prototyping, and manufacturing. Application of the design process and problem solving through individual and team projects. Two lecture hours and four laboratory hours a week for one semester. Only one of the following may be counted: Mechanical Engineering 302, 210, 210H.

M E 103. Studies in Engineering Design Graphics.

Computer laboratory work in engineering design graphics for students with transfer credit for Mechanical Engineering 210 who need additional work. Three computer laboratory hours a week for one semester. May not be counted by students with credit for Mechanical Engineering 302, 210, or 210H. Prerequisite: Consent of the undergraduate adviser.

M E 205. Introduction to Computers and Programming.

Introduction to computer hardware and software systems; programming using a high-level language; mathematical software programming; and introduction to machine language. Includes significant hands-on programming opportunities. One lecture hour and three laboratory hours a week for one semester. May not be taken concurrently with Mechanical Engineering 302. Prerequisite: Credit or registration for Mathematics 408C or 408K.

M E 210 (TCCN: ENGR 1204). Engineering Design Graphics.

Graphics and modeling fundamentals for engineering design: freehand sketching, computer modeling of solid geometry, and generation of engineering drawings. Introduction to reverse engineering, computer-aided design, rapid prototyping, and manufacturing. Application of the design process to problem solving. Individual and team design projects. Two lecture hours and three laboratory hours a week for one semester. Only one of the following may be counted: Mechanical Engineering 302, 210, 210H. May not be counted toward the Bachelor of Science in Mechanical Engineering degree. Prerequisite: Credit or registration for Mathematics 408C or 408K.

M E 210H. Engineering Design Graphics: Honors.

Graphics and modeling fundamentals for engineering design: freehand sketching, computer modeling of solid geometry, and generation of engineering drawings. Introduction to reverse engineering, computer-aided design, rapid prototyping, and manufacturing. Application of the design process to problem solving. Individual and team design projects. One lecture hour and four laboratory hours a week for one semester. Only one of the following may be counted: Mechanical Engineering 302, 210, 210H. May not be counted toward the Bachelor of Science in Mechanical Engineering degree. Prerequisite: Credit or registration for Mathematics 408C or 408K, and admission to an engineering honors program.

M E 310T. Applied Thermodynamics.

First and second laws of thermodynamics; thermodynamics processes, cycles, and heat transfer. Three lecture hours a week for one semester. Mechanical Engineering 320 and 310T may not both be counted. May not be counted toward the Bachelor of Science in Mechanical Engineering degree. Prerequisite: Chemistry 301, Mathematics 408D or 408M, and Physics 301 or 303K with a grade of at least C- in each.

M E 311. Materials Engineering.

An exploration of fundamental aspects of the structure, properties, and behavior of engineering materials. Three lecture hours a week for one semester. Prerequisite: The following courses with a grade of at least C- in each: Chemistry 301, Mechanical Engineering 302, Physics 303K, 103M; and credit or registration for Mechanical Engineering 111L, Physics 303L, and 103N.

M E 111L. Materials Engineering Laboratory.

Hands-on experiments in materials science and engineering topics and microstructure-property relationships discussed in Mechanical Engineering 311. One lecture hour and three laboratory hours a week for one semester. Prerequisite: Mechanical Engineering 302 with a grade of at least C-, and credit or registration for Mechanical Engineering 311.

M E 314D. Dynamics.

Analysis of motions, forces, momenta, and energies in mechanical systems. Three lecture hours and one discussion hour a week for one semester. Mechanical Engineering 314D and 324 may not both be counted. Prerequisite: Engineering Mechanics 306 and Mathematics 408D or 408M with a grade of at least C- in each.

M E 316T. Thermodynamics.

Properties, heat and work, first and second laws, thermodynamic processes, introduction to ideal power cycles. Three lecture hours a week for one semester, with additional hours to be arranged. Only one of the following may be counted: Mechanical Engineering 326, 326H, 316T. Prerequisite: Chemistry 301, Mathematics 408D or 408M, and Physics 301 or 303K with a grade of at least C- in each.

M E 218. Engineering Computational Methods.

Applied numerical analysis, programming of computational algorithms using mathematical software, and applications of computational methods to the solution of mechanical engineering problems. One and one-half lecture hours and one and one-half laboratory hours a week for one semester. Prerequisite: Mathematics 427J or 427K and Mechanical Engineering 205 with a grade of at least C- in each.

M E 318M. Programming and Engineering Computational Methods.

An investigation of applied numerical analysis, programming of computational algorithms using mathematical software, and applications of computational methods to the solution of mechanical engineering problems. Two lecture hours and one and one-half laboratory hours a week for one semester. Prerequisite: Mathematics 427J or 427K with a grade of at least C-.

M E 119S, 219S, 319S, 419S, 519S, 619S, 719S, 819S, 919S. Topics in Mechanical Engineering.

Used to record credit the student earns while enrolled at another institution in a program administered by the University's Study Abroad Office. Credit is recorded as assigned by the study abroad adviser in the Department of Mechanical Engineering. University credit is awarded for work in an exchange program; it may be counted as coursework taken in residence. Transfer credit is awarded for work in an affiliated studies program. May be repeated for credit when the topics vary.

Upper-Division Courses

M E 320. Applied Thermodynamics.

First and second laws of thermodynamics; thermodynamic processes, cycles, and heat transfer. Three lecture hours a week for one semester. Mechanical Engineering 320 and 310T may not both be counted. May not be counted toward the Bachelor of Science in Mechanical Engineering degree. Prerequisite: Chemistry 301, Mathematics 408D, and Physics 303K.

M E 120C. Humanitarian Engineering Seminar.

Restricted to students pursuing Humanitarian Engineering certificate. One lecture hour a week for one semester. Mechanical Engineering 120C and 179M (Topic: Seminar in Humanitarian Engn) may not both be counted. Prerequisite: Consent of instructor.

M E 324. Dynamics.

Analysis of motions, forces, momenta, and energies in mechanical systems. Three lecture hours and one discussion hour a week for one semester. Mechanical Engineering 314D and 324 may not both be counted. Prerequisite: Engineering Mechanics 306 and Mathematics 408D with a grade of at least C- in each; and credit or registration for Mechanical Engineering 318M.

M E 326. Thermodynamics.

Properties, heat and work, first and second laws, thermodynamic processes, introduction to ideal power cycles. Three lecture hours a week for one semester. For some sections, two discussion hours a week are also required. Only one of the following may be counted: Mechanical Engineering 326, 326H, 316T. Prerequisite: Chemistry 301, Mathematics 408D, and Physics 303K with a grade of at least C- in each.

M E 326H. Thermodynamics: Honors.

Properties, heat and work, first and second laws, thermodynamic processes, introduction to ideal power cycles. Three lecture hours a week for one semester. For some sections, two discussion hours a week are also required. Only one of the following may be counted: Mechanical Engineering 326, 326H, 316T. Prerequisite: Chemistry 301, Mathematics 408D, and Physics 303K with a grade of at least C- in each, and admission to an engineering honors program.

M E 129S, 229S, 329S, 429S, 529S, 629S, 729S, 829S, 929S. Topics in Mechanical Engineering.

Used to record credit the student earns while enrolled at another institution in a program administered by the University's Study Abroad Office. Credit is recorded as assigned by the study abroad adviser in the Department of Mechanical Engineering. University credit is awarded for work in an exchange program; it may be counted as coursework taken in residence. Transfer credit is awarded for work in an affiliated studies program. May be repeated for credit when the topics vary.

M E 330. Fluid Mechanics.

Fluid properties, statics, conservation laws, inviscid and viscous incompressible flow, flow in confined streams and around objects. Three lecture hours a week for one semester. Prerequisite: Engineering Mechanics 306, Mathematics 427J or 427K, and Mechanical Engineering 316T or 326 or 326H, with a grade of at least C- in each; and credit or registration for Mechanical Engineering 130L.

M E 130L. Experimental Fluid Mechanics.

Experimental design concepts, uncertainty analysis, and systems analysis as applied to thermodynamics, fluid mechanics, and heat transfer systems. One lecture hour and two laboratory hours a week for one semester. Prerequisite: Credit or registration for Mechanical Engineering 330.

M E 333H. Engineering Communication: Honors.

Professional communication skills for engineers, with emphasis on research, writing, editing, and oral presentation on topics of social and technical significance in engineering. Students collaborate to publish an online journal. Two lecture hours and two laboratory hours a week for one semester. Mechanical Engineering 333H and 333T may not both be counted. Prerequisite: Rhetoric and Writing 306 with a grade of at least C-, and admission to an engineering honors program.

M E 333T. Engineering Communication.

Professional communication skills for engineers, with emphasis on research, writing, and oral presentation on topics of social and technical significance in engineering. Two lecture hours and two laboratory hours a week for one semester. Only one of the following may be counted: Aerospace Engineering 333T, Biomedical Engineering 333T, Communication 333T, Civil Engineering 333T, Chemical Engineering 333T, Electrical and Computer Engineering 333T, Electrical Engineering 333T, Engineering Studies 333T, Mechanical Engineering 333T, Petroleum and Geosystems Engineering 333T. Prerequisite: Rhetoric and Writing 306 or English 303C with a grade of at least C-.

M E 334. Materials Engineering.

Fundamental aspects of the structure, properties, and behavior of engineering materials. Three lecture hours a week for one semester. Prerequisite: Chemistry 301 with a grade of at least C- and credit or registration for the following: Mechanical Engineering 134L; Physics 303L or 316; Physics 103N, 105N, or 116L; and Engineering Mechanics 319.

M E 134L. Materials Engineering Laboratory.

Hands-on experiments in materials science and engineering topics and microstructure-property relationships discussed in Mechanical Engineering 334. One lecture hour and three laboratory hours a week for one semester. Prerequisite: Credit or registration for Mechanical Engineering 334 and Engineering Mechanics 319.

M E 335. Engineering Statistics.

Fundamentals of probability, distribution theory, data analysis and statistics, interval estimation, hypothesis testing, and statistical quality control. Three lecture hours and one discussion hour a week for one semester. Prerequisite: Mathematics 408D or 408M with a grade of at least C-

M E 336. Materials Processing.

Effects of processing on materials properties; materials selection. Three lecture hours a week for one semester. Prerequisite: Mechanical Engineering 334 (or 311) and 134L (or 111L) or the equivalent and Engineering Mechanics 319 with a grade of at least C- in each.

M E 136L. Materials Processing Laboratory.

Hands-on study of selected materials processing procedures and processing-microstructure-property relationships discussed in Mechanical Engineering 336. One lecture hour and three laboratory hours a week for one semester. Prerequisite: Mechanical Engineering 111L and Engineering Mechanics 319 with a grade of at least C- in each, concurrent enrollment in Mechanical Engineering 336.

M E 136N, 236N. Concepts in Nuclear and Radiation Engineering.

Restricted to students in the Colleges of Engineering, Liberal Arts, and Natural Sciences, and the Jackson School of Geosciences. For Mechanical Engineering 136N, one lecture hour a week for one semester; for 236N, the equivalent of two lecture hours a week for one semester. Prerequisite: Completion of at least thirty semester hours of college coursework, or consent of instructor.

M E 336P. Concepts in Nuclear and Radiation Engineering.

Introduces the many different aspects and applications of nuclear and radiation engineering/physics. Subjects covered include: history of nuclear development, basic concepts of radiation and radioactivity, radioactive waste management, global warming and the impact of nuclear power plants, industrial applications, health physics, nuclear medicine, job opportunities at power plants, non-proliferation, nuclear security, discussion of opportunities for graduate schools at national laboratories, tour of University of Texas nuclear research reactor along with three introductory laboratories. Three lecture hours a week for one semester. Mechanical Engineering 336P and 379M (Topic: Concepts in Nuclear and Radiation Engineering) may not both be counted. Prerequisite: For engineering majors, Physics 303L and 103N or Physics 316 and 116L with a grade of at least C- in each; for others, upper-division standing.

M E 337C. Introduction to Nuclear Power Systems.

Radioactivity, nuclear interactions: fission and fusion, fission reactors, nuclear power systems, nuclear power safety. Three lecture hours a week for one semester. Prerequisite: For engineering majors, Mechanical Engineering 318M or 218 with a grade of at least C-; Physics 303L and 103N or Physics 316 and 116L with a grade of at least C- in each; for others, upper-division standing and written consent of instructor.

M E 337F. Nuclear Environmental Protection.

Ionizing radiation and its interactions with matter and living tissues; radioactive decay kinetics; external and internal dose measurement; transportation through the environment; managing radioactive waste streams; and safeguards. Three lecture hours a week for one semester. Mechanical Engineering 337F and 389C may not both be counted. Prerequisite: For engineering majors, Physics 303L and 103N or Physics 316 and 116L with a grade of at least C- in each; for others, upper-division standing.

M E 337G. Nuclear Safety and Security.

An investigation of policy and technical aspects related to nuclear safety and security. Participants will evaluate the proliferation of risk from facilities within the nuclear fuel cycle. They will calculate the criticality conditions for a nuclear assembly and derive parent/daughter decay equations. Nuclear forensics evaluations will be conducted on real-world environmental measurements. Three lecture hours a week for one semester. Prerequisite: For engineering majors, Physics 303L and 103N or Physics 316 and 116L with a grade of at least C- in each; for others, upper-division standing and written consent of instructor.

M E 338. Machine Elements.

Analysis for the design and manufacture of basic mechanical elements, and their role in the design of machines; application of finite element modeling. Three lecture hours a week for one semester. Prerequisite: Engineering Mechanics 319 and Mechanical Engineering 334 with a grade of at least C- in each.

M E 339. Heat Transfer.

Steady and transient heat conduction; forced and natural convection; radiation; introduction to heat exchangers and applications. Three lecture hours a week for one semester. Prerequisite: Mechanical Engineering 218 or 318M, 330, and 130L with a grade of at least C- in each; and credit or registration for Mechanical Engineering 139L.

M E 139L. Experimental Heat Transfer.

Experimental design concepts, uncertainty analysis, and systems analysis as applied to thermodynamics, fluid mechanics, and heat transfer systems. One lecture hour and two laboratory hours a week for one semester. Prerequisite: Credit or registration for Mechanical Engineering 339.

M E 340. Mechatronics.

Theory and application of electrical circuits, electronics, and electromechanical devices; concepts in electrical power transmission; instrumentation; feedback; integration of electronics and instrumentation with mechanical engineering systems (mechatronics). Three lecture hours a week for one semester. Aerospace Engineering 375 and Mechanical Engineering 340 may not both be counted. Prerequisite: Mechanical Engineering 318M; Physics 303L or 316; Physics 103N, 105N, or 116L with a grade of at least C- in each; and credit or registration for Mechanical Engineering 140L.

M E 140L. Mechatronics Laboratory.

Hands-on laboratory using hand-held and bench-top electronic test and prototyping equipment for circuits and mechatronics applications; computer-aided instrumentation and data acquisition; laboratory study in design, prototyping, and testing with electrical and electronics components and electromechanical devices. One lecture hour and two laboratory hours a week for one semester. Prerequisite: Credit or registration for Mechanical Engineering 340.

M E 343. Thermal-Fluid Systems.

Analysis and design of integrated systems involving simultaneous application of thermodynamics, heat transfer, and fluid mechanics. Applications to power generation, vehicle engineering, materials processing, environmental control, and manufacturing. Three lecture hours and one discussion hour a week for one semester. Prerequisite: Mechanical Engineering 330, 130L, 339, and 139L with a grade of at least C- in each.

M E 344. Dynamic Systems and Controls.

Lumped physical system models; electrical, fluid, mechanical, and thermal system analysis; linear system transient, steady-state behavior; introduction to feedback control. Three lecture hours a week for one semester. Prerequisite: Mathematics 427J or 427K, Mechanical Engineering 205 or 318M, and 324 or 314D with a grade of at least C- in each; Mechanical Engineering 340 and 140L with a grade of at least C- in each; and credit or registration for Mechanical Engineering 144L or 244L.

M E 144L, 244L. Dynamic Systems and Controls Laboratory.

Modeling of engineering systems, digital simulation, and assessment of results with experimental study; methods for analysis of first- and second-order systems, system identification, frequency response and feedback control principles; hands-on experimentation with mechanical, fluid, electrical, and magnetic systems; data acquisition and analysis using oscilloscopes and microcomputer-based analog-to-digital and digital-to-analog conversion; theoretical and practical principles governing the design and use of various sensors and transducers. For 144L, one lecture hour and two laboratory hours a week for one semester; for 244L, one lecture hour and three laboratory hours a week for one semester. Prerequisite: Credit or registration for Mechanical Engineering 344.

M E 347. Processing of Materials.

Analysis of forces in processing operations; effects of friction and their control; metalworking efficiencies. Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: For engineering majors, Mechanical Engineering 334 or the equivalent; for nonengineering majors, upper-division standing and written consent of instructor.

Topic 1: Powder Processing. Powder particle characterization and size/shape/distribution, powder synthesis, compaction, sintering theory, sintering maps, full-density processing, powder-processed part microstructure and properties.
Topic 2: Deformation Processing. Analysis of forces in processing operations; effects of friction and their control; slab method; upper-bound force theory; slip-line field theory; metalworking efficiencies.

M E 348E. Advanced Mechatronics I.

Integrated use of mechanical, electrical, and computer systems for information processing and control of machines and devices. System modeling, electromechanics, sensors and actuators, basic electronics design, signal processing and conditioning, noise and its abatement, grounding and shielding, filters, and system interfacing techniques. Three lecture hours and two laboratory hours a week for one semester. Mechanical Engineering 348C and 348E may not both be counted. Prerequisite: For engineering majors, Mechanical Engineering 340 or the equivalent; for nonengineering majors, upper-division standing and written consent of instructor.

M E 348F. Advanced Mechatronics II.

Interfacing microcomputers with sensors and actuators; hybrid (analog/digital) design; digital logic and analog circuitry; data acquisition and control; microcomputer architecture, assembly language programming; signal conditioning, filters, analog-to-digital and digital-to-analog conversion. Three lecture hours and two laboratory hours a week for one semester. Mechanical Engineering 348D and 348F may not both be counted. Prerequisite: For engineering majors: Mechanical Engineering 340 or the equivalent; for nonengineering majors: upper-division standing and written consent of instructor.

M E 349. Corrosion Engineering.

Corrosion principles; electrochemical, environmental, and metallurgical effects; types of corrosion; corrosion testing and prevention; modern theories: principles and applications. Three lecture hours a week for one semester. Prerequisite: For engineering majors, Mechanical Engineering 334 (or 311) or the equivalent with a grade of at least C-, Mechanical Engineering 316T or 326 (or 326H) or the equivalent with a grade of at least C-; for others, upper-division standing and written consent of instructor.

M E 350. Machine Tool Operations for Engineers.

Hands-on manual and computer-numerical-controlled machine tool operation. Part design and tool selection for production. One lecture hour and six laboratory hours a week for one semester. Mechanical Engineering 350 and 379M (Topic 7: Machine Tool Operations for Engineers) may not both be counted. Offered on the letter-grade basis only.

M E 350D. Design and Control of Robots for Rehabilitation.

Explore the roles of sensors, actuators, and neural circuits for biological movement control from an engineering perspective. Examine current approaches to robotic and mechatronic devices that support and enhance human movement in health and following neurologic injuries like stroke and spinal cord injury are discussed. Study the latest literature in neuromuscular controls, neuromotor recovery, and design and control of rehabilitation robots. Three lecture hours a week for one semester. Mechanical Engineering 350D and 379M (Topic: Dsgn/Cntrl Of Robots For Rehab) may not both be counted. Prerequisite: Consent of instructor.

M E 350R. Robot Mechanism Design.

Studies the analysis and synthesis of motions of mechanisms in order to design robotic systems. Examines motion properties of mechanisms including degrees of freedom, velocity, and acceleration. Explores ideas and motion analysis for robotic systems for a wide range of applications including spatial, industrial and medical robotics. Three lecture hours a week for one semester. Mechanical Engineering 350R and 379M (Topic: Robot Mechanism Design) may not both be counted. Prerequisite: Engineering Mechanics 306, and Mechanical Engineering 218 or 318M and 314D or 324, with a grade of at least C- in each.

M E 352K. Engineering Computer Graphics.

Introduction to interactive computer graphics as a tool in computer-aided design. Use of graphics software packages. Two lecture hours and three laboratory hours a week for one semester. Prerequisite: For non-engineering majors, upper-division standing and written consent of instructor.

M E 353. Engineering Finance.

Evaluating the financial impact of engineering decisions. Comparing alternatives with cash flow analysis considering rate of return, inflation, and taxes, with emphasis on analyzing risk. Managing complex projects with activity scheduling and resource allocation considering cash flows. Methods include probabilistic analysis and simulation. Three lecture hours and two discussion hours a week for one semester. Prerequisite: Mechanical Engineering 335 with a grade of at least C-.

M E 354. Introduction to Biomechanical Engineering.

The application of mechanical engineering principles to problems in the life sciences; transport phenomena of physiological solids and fluids; biosignal analysis and instrumentation; biomaterials design and compatibility; principles of medical imaging, diagnostics, and therapeutics; rehabilitation engineering. Three lecture hours a week for one semester. Prerequisite: For engineering majors, Mathematics 427J or 427K with a grade of at least C-; for others, upper-division standing and written consent of instructor.

M E 354M. Biomechanics of Human Movement.

Modeling and simulation of human movement; neuromuscular control; computer applications; introduction to experimental techniques. Three lecture hours a week for one semester. Biomedical Engineering 342 and Mechanical Engineering 354M may not both be counted. Prerequisite: For non-engineering majors, upper-division standing and written consent of instructor.

M E 355K. Engineering Vibrations.

Time-domain and frequency-domain analysis of vibrating systems; matrix methods, instrumentation, and vibration control; numerical methods. Three lecture hours a week for one semester. Prerequisite: Mathematics 427J or 427K, and Mechanical Engineering 314D or 324 with a grade of at least C- in each.

M E 259, 359. Materials Selection.

Description of commercial metals, polymers, ceramics, concrete, and wood for use in mechanical engineering applications. Applications include strength, toughness, stiffness, fatigue, creep, corrosion, casting, forming, machining, and welding. Two or three lecture hours a week for one semester. Prerequisite: For engineering majors, Mechanical Engineering 334 or the equivalent; for nonengineering majors, upper-division standing and written consent of instructor.

M E 360. Vehicle System Dynamics and Controls.

Fundamentals of ground vehicle dynamics, tire-road mechanics, vehicle control systems, vehicle stability, and simulation of vehicle systems. Three lecture hours a week for one semester. Only one of the following may be counted: Mechanical Engineering 360, 379M (Topic: Vehicle System Dynamics and Controls), 390, 397 (Topic: Vehicle System Dynamics and Controls). Prerequisite: For engineering majors, Mechanical Engineering 344 with a grade of at least C-; for others, upper-division standing and written consent of instructor.

M E 360C. Cyber Vehicle Systems.

Study of the engineering principles of autonomous mobile robots. Subjects include understanding the dynamics of vehicle systems, and the principles and practical implementation of sensing, actuation, and control. Emphasis on providing practical laboratory study of these subjects using mobile robot platforms, and the use of the commercial software package LabVIEW for programming of real-time data acquisition and control targets. Simulation studies may also be conducted in LabVIEW and/or the Matlab environment, so some proficiency in use of both of these software packages is expected. Three lecture hours a week for one semester. Only one of the following may be counted: Mechanical Engineering 360C, 379M (Topic: Cyber Vehicle Systems), 390C, 397 (Topic: Cyber Vehicle Systems). Prerequisite: For engineering majors, Mechanical Engineering 344 with a grade of at least C-; for others, upper-division standing and written consent of instructor.

M E 360D. Propulsion Systems and Controls.

Study principles, modeling, analysis, system integration, control, and diagnosis of diverse ground vehicle propulsion and driveline systems. Three lecture hours a week for one semester. Mechanical Engineering 360D and 379M (Topic: Propulsion Systems/Control) may not both be counted. Prerequisite: Upper-division standing.

M E 360E. Advanced Vehicle Powertrain Systems and Control.

Explore the basic concept of vehicle powertrain systems and controller design, and discuss state of the art vehicle powertrain development. Examine modeling skills to capture the system dynamics and modern control strategies to achieve the desired system performance. Three lecture hours a week for one semester. Mechanical Engineering 360E and 379M (Topic: Adv Vehicle Powertrn Sys/Cont) may not both be counted.

M E 260K, 360K. Metallurgy of Engineering Alloys.

Microstructure and property relationships of metals and alloys; steel alloys; aluminum alloys; titanium alloys; magnesium alloys; solidification and casting; thermomechanical processing; heat treating and solid-state phase transformations. Two or three lecture hours a week for one semester. Prerequisite: For engineering majors, Mechanical Engineering 334 (or 311) or the equivalent with a grade of at least C-; for others, upper-division standing and written consent of instructor.

M E 360L. Turbomachinery and Compressible Flow.

Positive displacement and dynamic rotating machinery; pumps, compressors, and turbines; performance characteristics and scaling laws. One-dimensional compressible flow with area change, friction, or heat addition. Normal and oblique shock waves; Prandtl-Meyer expansion. Three lecture hours a week for one semester. Prerequisite: Mechanical Engineering 330, 130L and 139L.

M E 360N. Intermediate Heat Transfer.

Multidimensional and transient diffusion; laminar and turbulent convection; radiation exchange; special topics. Three lecture hours a week for one semester. Prerequisite: Mechanical Engineering 339.

M E 361E. Nuclear Reactor Operations and Engineering.

Fission and chain reactions; neutron diffusion and moderation; reactor equations; Fermi Age theory; and multigroup and multiregional analysis. Three lecture hours a week for one semester. Prerequisite: For engineering majors, Mechanical Engineering 318M or 218 and Physics 303L and 103N or Physics 316 and 116L with a grade of at least C- in each; for others, upper-division standing and written consent of instructor.

M E 361F. Radiation and Radiation Protection Laboratory.

Introduction to the application of radiation and radiation protection instrumentation. Lecture and laboratory topics include personnel monitoring, radiation detection systems, gamma-ray spectroscopy, determination of environmental radiation, counting statistics, gamma and neutron shielding, and air sampling. Two lecture hours and three laboratory hours a week for one semester. Prerequisite: For engineering majors, Mechanical Engineering 318M or 218 with a grade of at least C-, Physics 303L and 103N or Physics 316 and 116L with a grade of at least C- in each; for others, upper-division standing and written consent of instructor.

M E 261M, 361M. Materials Thermodynamics.

First and second laws; heat of combustion; heat engine cycles; chemical equilibria and/or phase equilibria; point defects in crystals. Two or three lecture hours a week for one semester. Prerequisite: For engineering majors, Mechanical Engineering 334 (or 311) or the equivalent with a grade of at least C-, Mechanical Engineering 326 or 326H with a grade of at least C-; for others, upper-division standing and written consent of instructor.

M E 362K. Readings in Engineering.

A study of the interrelated problems of society, technology, and energy. Three lecture hours a week for one semester. Only one of the following may be counted: Mechanical Engineering 325L, 362K, 371K, 177K, 277K, 377K.

M E 362S. Development of a Solar-Powered Vehicle.

Analysis, design, and construction of a solar-powered car for national competitions involving other universities. Study of electrical, mechanical, and aerodynamic systems. Three lecture hours and three laboratory hours a week for one semester. Only one of the following may be counted: Electrical and Computer Engineering 362S, Electrical Engineering 362S, Mechanical Engineering 362S. Prerequisite: Consent of instructor.

M E 363L. Energy Systems Laboratory.

Experimental analysis of thermal energy systems, including heat transfer equipment, engines, the University chilling station and the University power plant. Use of a variety of industrial instrumentation for assessment of system and component performance and of experimental uncertainty. Written and oral technical communication of experimental results. Two lecture hours and three laboratory hours a week for one semester. Prerequisite: Mechanical Engineering 339 and 139L.

M E 363M. Energy Technology and Policy.

An overview of energy technologies, fuels, environmental impacts and public policies. Subjects are interdisciplinary and include an introduction to quantitative concepts in energy, including the differences among fuels and energy technologies, energy policy levers, and the societal aspects of energy, such as culture, economics, war, and international affairs. Includes brief snippets of energy history, use of real-world examples, and looks forward into the future. Interactive and lecture-oriented around current events related to energy. Three lecture hours a week for one semester. Mechanical Engineering 363M and 379M (Topic: Energy Technology and Policy) may not both be counted. Prerequisite: Upper-division standing.

M E 364D. Intermediate Dynamics.

Focuses on efficient formulation and solution of equations of motion for complex 3D multi-body mechanical systems. Emphasizes the formulation of the dynamical equations of motion using Kane's method and will use symbolic and numerical simulation techniques (MATLAB(R) and MotionGenesis) to solve these equations. Preparation for advanced research and professional work analyzing the dynamics of complex multi-body mechanical systems. Three lecture hours a week for one semester. Mechanical Engineering 364D and 379M (Topic: Intermediate Dynamics) may not both be counted. Prerequisite: Upper-division standing and the following courses with a grade of at least a C-: Mechanical Engineering 314D or equivalent and 318M or equivalent.

M E 364L. Automatic Control System Design.

Feedback principles; control components; industrial compensators; Routh, Nyquist, Bode, and root locus methods; controller design; continuous and discrete time control. Three lecture hours and one-half laboratory hour a week for one semester. Prerequisite: Mechanical Engineering 344.

M E 365D. Data Science for Engineers.

Same as Operations Research and Industrial Engineering 365. Learn data analysis and programming skills. Explore essential data science techniques, including regression, decision trees, classification, and neural networks. Three lecture hours a week for one semester. Only one of the following may be counted: Mechanical Engineering 365D, 379M (Topic: Data Science for Engineers), Operations Research and Industrial Engineering 365. Prerequisite: Upper-division standing; Mechanical Engineering 205 or 318M, and Mechanical Engineering 335

M E 365E. Engineering Entrepreneurship.

Focus on developing a basic understanding for the assessment of emerging technologies including the analysis of the status and future development issues, establish a comprehension of what 'market' means in terms of potential technology applications, and of how that market is identified and characterized. Create new knowledge about the potential match of an emerging technology with a defined market as a member of a multidisciplinary team, establish a basic understanding of IP rights, assessment and strategy related to emerging technology, and assess the course and participate in discussions about how it can be evolved for future offerings. Exploration the innovation and technology commercialization process especially as it relates to individual expertise and career goals. Three lecture hours a week for one semester. Mechanical Engineering 365E and 379M (Topic: Engineering Entrepreneurship) may not both be counted. Prerequisite: Upper-division standing.

M E 365K. Finite Element Method.

Introduction and application of the finite element method in engineering analysis and design problems; demonstration of techniques using commercial codes. Three lecture hours a week for one semester. Prerequisite: Engineering Mechanics 319 and Mathematics 427J or 427K with a grade of at least C- in each.

M E 365L. Industrial Design for Production.

Current techniques for making transitions from theoretical concepts to cost effective designs suitable for manufacturing. Three lecture hours a week for one semester. Prerequisite: Mechanical Engineering 338.

M E 366J. Mechanical Engineering Design Methodology.

An examination of structured methodologies for designing mechanical systems; reverse engineering/redesign projects and conceptual design projects. Three lecture hours and two laboratory hours a week for one semester. Prerequisite: The following coursework with a grade of at least C- in each: Mechanical Engineering 302, 330, 130L, 335, 338, 339, 139L, 340, and 140L; one of the following with a grade of at least C-: Mechanical Engineering 333H, 333T, Aerospace Engineering 333T, Biomedical Engineering 333T, Chemical Engineering 333T, Civil Engineering 333T, Electrical Engineering 333T, Engineering Studies 333T or Petroleum and Geosystems Engineering 333T.

M E 266K. Mechanical Engineering Design Project.

Creative design, analysis, selection, development, and fabrication of engineering components and systems. Development of team project with faculty adviser and sponsoring engineer. Two lecture hours a week for one semester, with additional hours to be arranged. Prerequisite: Mechanical Engineering 344, 144L or 244L, 353, and 366J with a grade of at least C- in each.

M E 366L. Operations Research Models.

Same as Operations Research and Industrial Engineering 366. Formulation and solution-interpretation for operations research models requiring, for example, optimization, simulation, or analysis of Markov chains or queues. Applications include manufacturing design and control, routing and scheduling, plant location, inventory analysis, and management of queueing systems. Three lecture hours a week for one semester. Mechanical Engineering 366L and Operations Research and Industrial Engineering 366 may not both be counted. Prerequisite: For engineering majors, Mathematics 408D or 408M and Mechanical Engineering 318M with a grade of at least C- in each; for non-engineering majors, upper-division standing and written consent of instructor.

M E 266P. Design Project Laboratory.

Development of individual team project in association with faculty adviser and sponsoring project engineer. Four laboratory hours a week for one semester. Prerequisite: Mechanical Engineering 344, 144L or 244L, 353, and 366J with a grade of at least C- in each.

M E 366Q. Deterministic Methods for Operations Research.

Theory and algorithms for deterministic operations research methods. Algorithms for solving linear, integer, and nonlinear optimization models. Three lecture hours a week for one semester. Prerequisite: For non-engineering majors, upper-division standing and written consent of instructor.

M E 366R. Stochastic Methods for Operations Research.

Theory and algorithms for stochastic operations research methods. Algorithms related to stochastic processes: Markov chain analysis; queueing theory; stochastic inventory theory and decision analysis. Three lecture hours a week for one semester. Prerequisite: For engineering majors, Mechanical Engineering 335 or the equivalent; for non-engineering majors, upper-division standing and written consent of instructor.

M E 366T. Biomems and Bionems.

Micro/Nano technology has been used to create many new materials and devices with a vast range of applications in materials science, electronics and photonics, and biomedical applications. BioMEMS and BioNEMS is the application of micro/nano technology in the fields of biomedical and health sciences by offering advantages of small size (from submicron to a few mm), low cost, high throughput, and importantly requiring much less sample/reagent. Three lecture hours a week for one semester. Mechanical Engineering 366T and 379M (Topic: Biomems and Bionems) may not both be counted. Prerequisite: Upper-division standing.

M E 367S. Simulation Modeling.

Same as Operations Research and Industrial Engineering 367. Basic concepts of discrete-event simulation. Statistical input and output analysis. Application of simulation software. Modeling of systems under uncertainty. Three lecture hours a week for one semester. Mechanical Engineering 367S and Operations Research and Industrial Engineering 367 may not both be counted. Prerequisite: For engineering majors, Mechanical Engineering 318M with a grade of at least C-, Mechanical Engineering 335 or the equivalent; for non-engineering majors, upper-division standing and written consent of instructor.

M E 368C. Additive Manufacturing.

Additive manufacturing (AM) is the use of layer-based processes for producing parts directly from computer (CAD) models, without part-specific tooling. Students learn about a variety of additive manufacturing

(AM) AM technologies, their potential to support rapid prototyping and manufacturing, and some of of the important research challenges associated with AM. Three lecture hours a week for one semester. Mechanical Engineering 368C and 379M (Topic: Additive Manufacturing) may not both be counted. Prerequisite: Grade of at least C- or registration for Mechanical Engineering 366J.

M E 368J. Computer-Aided Design.

Application of computers to design problems and simulation of mechanical systems; creation of interactive special applications programs. Three lecture hours and two laboratory hours a week for one semester. Prerequisite: Credit or registration for Mechanical Engineering 338.

M E 369L. Introduction to Computational Fluid Dynamics.

Applied numerical analysis, including solution of linear algebraic equations and ordinary and partial differential equations; modeling of physical processes, including fluid flow and heat and mass transfer; use of general purpose computer codes, including commercial computational fluid dynamics software packages. Three lecture hours a week for one semester. Only one of the following may be counted: Aerospace Engineering 347, Computational Engineering 347, Mechanical Engineering 369L. Prerequisite: Credit or registration for Mechanical Engineering 330 and 339.

M E 369M. Computational Methods in Thermal/Fluid Systems.

Use of basic tools of computational mathematics to set up numerical simulations for a variety of problems in thermo fluids. Explicit versus implicit time-stepping schemes, the issues of numerical stability and numerical errors, the issue of computational costs, difficulties with boundary and initial conditions, basic decision paths in the choice of numerical methods depending on the target system, and design of diagnostic steps. Three lecture hours a week for one semester. Mechanical Engineering 369M and 379M (Topic: Comput Meth Thermal/Fluid Sys) may not both be counted. Prerequisite: Upper-division standing.

M E 369P. Application Programming for Engineers.

Designed for students who have some experience in programming and are interested in the sharing and development of open source software applications. Provides an introduction to the Python Programming language, an open source, flexible, and intuitive debug programming language, with an emphasis on system modeling, simulation, data analysis, and software/data management. Students will create mini projects in Python that demonstrate software design and organization, debugging, open source practices, and data visualization. Three lecture hours a week for one semester. Prerequisite: For engineering majors, Mechanical Engineering 318M or the equivalent with a grade of at least C-; for others, upper-division standing and written consent of instructor.

M E 371D. Medical Device Design and Manufacturing.

Explores how to solve medical device design problems using systematic design thinking and practices. Interpret clinical needs and define an open engineering medical device design problem, including formulating engineering requirements/specifications to address a marketable need, generate concepts in a way that promotes both creativity and usefulness, make well-informed, well-justified design decisions in the early and later stages of design, design and analyze experiments, follow statistical best practices in Design of Experiments(DoE), embody solutions with "Design for X" considerations, and communicate intermediate and final designs clearly and effectively in written and oral formats. Three lecture hours a week for one semester. Only one of the following may be counted: Biomedical Engineering 363E, 377T (Topic: Medical Device Design and Manufacturing), Mechanical Engineering 371D, 379M (Topic: Medical Device Design and Manu). Prerequisite: Upper-division standing.

M E 371K. Legal Aspects of Engineering Practice.

Legal considerations in the practice of engineering; specifications and contracts for equipment and engineering services. Three lecture hours a week for one semester. Only one of the following may be counted: Mechanical Engineering 325L, 362K, 371K, 177K, 277K, 377K. Prerequisite: Upper-division standing.

M E 372C. Theory and Design for Mechanical Sensing and Measurements.

Explore basic concepts of mechanical measurements: sensing, signal processing, experimental methods, uncertainty analysis, detection, and estimation. Three lecture hours a week for one semester. Mechanical Engineering 372C and 379M (Topic: Thry/Dsgn of Mech Measurement) may not both be counted. Prerequisite: Mechanical Engineering 335 and 340.

M E 372J. Robotics and Automation.

Component technologies for precision machines based on dynamic modeling and motion programming: cams, linkages, planar robot manipulators and open architecture vehicles. Homework includes 15 simulations. Three lecture hours a week for one semester. Prerequisite: Upper-division standing and credit or registration for Mechanical Engineering 324.

M E 372M. Mechanism Design.

Design of planar mechanisms for applications that require rigid body guidance, function generation, and path generation. Graphical and analytical techniques. Computer-aided design projects. Three lecture hours a week for one semester. Prerequisite: Credit or registration for Mechanical Engineering 324.

M E 372N. Design of Smart Mechanisms.

Design of reprogrammable multiple-degree-of-freedom architectures. The course addresses various mechanical configurations and stresses the integrated design approach to sensing/actuation/control architecture and control software. Three lecture hours a week for one semester. Prerequisite: Upper-division standing and consent of instructor.

M E 374C. Combustion Engine Processes.

Principles of internal combustion engines, fuels, carburetion, combustion, exhaust emissions, knock, fuel injection, and factors affecting performance. Three lecture hours a week for one semester. Prerequisite: Mechanical Engineering 339 or consent of instructor.

M E 374D. Automotive Engineering Laboratory.

Engines and emissions. Students use commercial engine-modeling software to explore effects of valve timing and intake tuning and conduct experiments with vehicle emissions, ignition timing, engine mechanisms, engine controls, and emissions control. One lecture hour and four laboratory hours a week for one semester. Prerequisite: Credit or registration for Mechanical Engineering 374C.

M E 374E. Race Car Engineering and Project Management.

Explores designing a Formula SAE race car, a hot rod (UT's 1937 Chevy project), and a Formula SAE Electric race car. Divided into four major sections: Project Management, including tools for project organization and management, Powertrain, including engine basics, calibration, intake and exhaust design, cooling and oiling systems, fuel economy and emissions, transmission/differential, vehicle performance modeling, Brake systems, longitudinal weight transfer, longitudinal force requirements of the tires for both braking and acceleration, tires and tire models, and Vehicle dynamics (suspension systems, anti-roll bars, lateral weight transfer, tires and tire models). Three lecture hours a week for one semester. Mechanical Engineering 374E and 379M (Topic: Racecar Engr & Proj Management) may not both be counted. Prerequisite: The following courses with a grade of at least a C- in each: Mechanical Engineering 330 and 130L; and credit or registration for 339 and 139L.

M E 374F. Fire Science.

Analysis of the dynamics and consequences of fire in structures. Topics include combustion thermochemistry, premixed and diffusion flames, fluid mechanics of fire, human tenability in burning structures, and computer modeling of fires. Three lecture hours a week for one semester. Prerequisite: For engineering majors, upper-division standing and credit or registration for Mechanical Engineering 339 and 139L with a grade of at least C- in each; for others, upper-division standing and written consent of instructor.

M E 374L. Design of Thermal Systems.

Methodology and approach to design of thermal energy systems; component and system modeling; optimization, including economic considerations. Three lecture hours a week for one semester. Prerequisite: Mechanical Engineering 339 or the equivalent.

M E 374R. Design of Air Conditioning Systems.

Load calculations, design of thermal distribution systems, component selection and control. Three lecture hours a week for one semester. Prerequisite: Credit or registration for Mechanical Engineering 339.

M E 374S. Solar Energy Systems Design.

Insolation characteristics and measurement, component design, solar energy system modeling, introduction to photovoltaic systems, cost analysis, and case studies. Three lecture hours a week for one semester. Prerequisite: Mechanical Engineering 339 or the equivalent.

M E 374T. Renewable Energy Technology.

Cultivates an enhanced level of theoretical and conceptual understanding of thermodynamics, fluid mechanics and heat transfer, and of how these disciplines apply to the design and analysis of complex thermal-fluid systems. Enhances skills in designing, programming and debugging software tools for systems analysis, working in teams, and communicating engineering results in a professional manner. Three lecture hours a week for one semester. Mechanical Engineering 374T and 379M (Topic: Renewable Energy Technology) may not both be counted. Prerequisite: The following courses with a grade of at least a C- in each: Mechanical Engineering 316T, 318M, 330, 130L, 339, and 139L.

M E 376N. High Throughput Nanopatterning.

Introduction to the basic tools and materials involved in the patterning processes needed to create nano-scale structures and functional materials and discusses the relevance of these processes to applications in the electronics, display, and energy industries. Includes take-home portable nano-labs which allow hands-on experience in nano-scale fabrication processes and relevant nanometrology techniques. Explores industry and research roadmaps that provide relevant metrics and timelines for fabrication, materials, nano-enabled components and devices. Exposure to relevant computational modeling and simulation tools allows exploration of novel nano-enabled components and devices. Three lecture hours a week for one semester. Mechanical Engineering 376N and 379M (Topic: High Throughput Nanopatterning) may not both be counted. Prerequisite: Upper-division standing.

M E 177K, 277K, 377K. Projects in Mechanical Engineering.

Independent project carried out under the supervision of a faculty member in mechanical engineering. Student prepares a project proposal and a final report, each of which is evaluated by the faculty committee on individual projects. For 177K, three to five laboratory hours and one consultation hour with the faculty supervisor a week for one semester; for 277K, five to ten laboratory hours and one consultation hour with the faculty supervisor a week for one semester; for 377K, ten to fifteen laboratory hours and one consultation hour with the faculty supervisor a week for one semester. Only one of the following may be counted: Mechanical Engineering 325L, 362K, 371K, 177K, 277K, 377K. Prerequisite: A University grade point average of at least 2.50 and a grade point average in the major of at least 2.50; and approval of project proposal by the faculty committee on individual projects.

M E 378C. Electroceramics.

Bonding; crystal structures; defects; phase diagrams; glass ceramics; electrical, dielectric, magnetic, and optical ceramics. Three lecture hours a week for one semester. Prerequisite: For engineering majors, Mechanical Engineering 334 (or 311) or the equivalent with a grade of at least C-; for others, upper-division standing and written consent of instructor.

M E 378D. Failure Analysis.

Introduction to methodology of analyzing failures of engineering parts and devices. Explores a broad range of analysis, but the focus is on understanding fractography and relating this back to material and mechanics relevant to failure to determine the likely root cause(s). Lectures are primarily based on case studies and are supplemented by two hands-on class projects, one performed individually and the other larger project performed as a team project. Three lecture hours a week for one semester. Mechanical Engineering 378D and 379M (Topic: Failure Analysis) may not both be counted. Prerequisite: For engineering majors, the following courses with a grade of at least a C- in each: Engineering Mechanics 319, Mechanical Engineering 334 and 134L or equivalent.

M E 378E. Nanotechnology for Sustainable Energy.

Demonstrates the role of nanoscale materials in solving one of the most critical socio-economic issues of our time, affordable and sustainable energy. An overview of emerging nanotechnology, and how people can critically impact many energy technologies (from energy harvesting, conversion, to storage). Explores various types of energy devices, including solar cell, solar fuel, piezoelectrics, thermoelectrics, battery, supercapacitor, and fuel cell as well as basic device principles, current technology status and new opportunities of nanotechnology for energy device applications. Content is at the intersection of nanoscale science and engineering, and energy science and technology. Three lecture hours a week for one semester. Mechanical Engineering 378E and 379M (Topic: Nanotech for Sustainabl Energy) may not both be counted. Prerequisite: Upper-division standing, and the following courses with a grade of at least C-: Chemistry 301, Mechanical Engineering 334 or equivalent, Physics 303L and 103N or Physics 316 and 116L.

M E 378F. Enhancing Sustainability Through Tribology.

Explore the principles of macro-scale tribology and discuss the potential impact of tribology in enhancing sustainable development. Discuss physical properties of lubricants; lubricants and their composition; contact mechanics; hydrodynamic lubrication; hydrostatic lubrication; elastohydrodynamic lubrication; boundary lubrication; solid lubrication and surface treatments; wear of materials; nanotribolgy; and green tribology. Three lecture hours a week for one semester. Mechanical Engineering 378F and 379M (Topic: Enhanc Sustnblty Thru Tribolgy) may not both be counted. Prerequisite: Chemistry 301, Mechanical Engineering 302, Mechanical Engineering 334, Physics 303K, and Physics 103M with a grade of at least C- in each.

M E 378K. Mechanical Behavior of Materials.

Elastic deformation; viscoelasticity; yielding, plastic flow, plastic instability, strengthening mechanisms; fracture, fatigue, creep; significance of mechanical properties tests. Three lecture hours a week for one semester. Prerequisite: For engineering majors, Mechanical Engineering 334 or the equivalent and 134L with a grade of at least C- in each; for others, upper-division standing and written consent of instructor.

M E 378P. Properties and Applications of Polymers.

Introduction to polymers as structural materials: polymerization, polymer structure, physical and mechanical properties, processing and fabrication. Three lecture hours a week for one semester. Prerequisite: For engineering majors, Mechanical Engineering 334 (or 311) or the equivalent with a grade of at least C-, Mechanical Engineering 326 or 326H or the equivalent with a grade of at least C-; for others, upper-division standing and written consent of instructor.

M E 378Q. Polymer Nanocomposites.

Fundamentals, properties, and applications of polymer nanocomposites. Three lecture hours a week for one semester. Mechanical Engineering 378Q and 379M (Topic: Polymer Nanocomposites) may not both be counted. Prerequisite: Mechanical Engineering 334 and 134L with a grade of at least C-.

M E 378S. Structural Ceramics.

Powder processing, powder characterization, forming techniques, densification, and development of microstructure; emphasis on understanding materials, selection, and microstructure-mechanical property relationships. Three lecture hours a week for one semester. Prerequisite: For engineering majors, Mechanical Engineering 334 (or 311) or the equivalent with a grade of at least C-; for others, upper-division standing and written consent of instructor.

M E 679H. Undergraduate Honors Thesis.

Research performed during two consecutive semesters under the supervision of an engineering faculty member; topics are selected jointly by the student and the faculty member with approval by the director of the Engineering Honors Program. The student makes an oral presentation and writes a thesis. Individual instruction for two semesters. Students pursuing both the Bachelor of Arts, Plan II, and a bachelor's degree in engineering may use this course to fulfill the thesis requirement for the Bachelor of Arts, Plan II. Prerequisite: For 679HA, enrollment in the Engineering Honors Program; for 679HB, Mechanical Engineering 679HA and enrollment in the Engineering Honors Program.

M E 179M, 279M, 379M. Topics in Mechanical Engineering.

For each semester hour of credit earned, the equivalent of one lecture hour a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Prerequisites vary with the topic.

Topic 1: Design of Machines and Systems. Restricted to students in the UTeach Engineering Program. Introduction to techniques for analyzing and designing machine components (linkages, cams, springs, gears, etc.) within the context of reverse engineering and redesigning existing products. Covers the application of structure methods for engineering design and prototyping. Mechanical Engineering 179M, 279M, 379M (Topic 1) and 379M (Topic: Design of Machines and Systems) may not both be counted.

M E 379N. Engineering Acoustics.

Same as Electrical and Computer Engineering 363N. Principles of acoustics, with applications drawn from audio engineering, biomedical ultrasound, industrial acoustics, noise control, room acoustics, and underwater sound. Three lecture hours a week for one semester. Only one of the following may be counted: Electrical and Computer Engineering 363N, Electrical Engineering 363N, Mechanical Engineering 379N. Prerequisite: Mathematics 427J or 427K with a grade of at least C-.

M E 379Q. Musical Acoustics.

Same as Music 379Q. Designed to help students develop the intuition and vocabulary for understanding the basic physical principles relevant to musical instruments and sound (e.g., mechanics, vibrations, acoustics, harmonics, acoustic-electronic conversions, speakers, hearing, perception, room acoustics) in order to be able to read basic articles on the subject of musical acoustics. Material is kept relevant to musical principles (e.g., performance techniques, scales/harmony) throughout. Three lecture hours a week for one semester. Only one of the following may be counted: Arts and Entertainment Technologies 320D, 339 (Topic: Musical Acoustics), Mechanical Engineering 379M (Topic: Musical Acoustics), 379Q, Music 376J (Topic: Musical Acoustics), 379Q.

Graduate Courses

M E 180E, 280E, 380E. Special Topics in Mechanical Engineering.

Restricted to mechanical engineering option III program. For each semester hour of credit earned, the equivalent of one lecture hour a week for one semester. May be repeated for credit when the topics vary. Offered on the letter-grade basis only. Prerequisite: Graduate standing.

M E 180M, 280M, 380M, 680M, 980M. Research.

Individual research. May be repeated for credit. Offered on the credit/no credit basis only. Prerequisite: Graduate standing in mechanical engineering.

M E 380Q. Mathematical Methods in Engineering.

Applications of mathematical analysis and numerical concepts to typical engineering problems. Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing, and Mathematics 427K or the equivalent.

Topic 1: Engineering Analysis: Analytical Methods. Analytical solutions for linear ordinary differential equations; numerical integration of ordinary differential equations; Fourier series and integrals; the Laplace transform; the solution of partial differential equations; vector analysis and linear transformations.
Topic 2: Engineering Analysis: Advanced Analytical Methods. Classification and solution of partial differential equations; includes linear superposition, separation of variables, Fourier and Laplace transform methods, Green's functions, similarity solution, and spectral methods; introduction to solution of nonlinear partial differential equations, including both exact and approximate techniques, with a strong emphasis on physical systems.
Topic 3: Perturbation Methods. Introduction to perturbation theory; regular expansions and sources of nonuniformities; method of strained coordinates and multiple scales; method of matched asymptotic and composite expansions. Places strong emphasis on the relationship between the physical and the mathematical basis and on the crucial role of nondimensionalization in problem solving.
Topic 4: Numerical Methods for Differential Equations. Numerical solution of ordinary differential equations, both initial and boundary value equations; includes quasilinearization, shooting methods, and method of adjoints; classification and solution of partial differential equations by the finite difference method; stability and convergence criteria for various schemes; special attention to nonlinear equations with a strong emphasis on the Navier-Stokes equations.

M E 380R. Robot Mechanism Design.

Examines analysis and synthesis of motions of mechanisms in order to design robotic systems. Motion properties of mechanisms including degrees of freedom, velocity, and acceleration will be studied. Discusses design ideas and motion analysis for robotic systems for a wide range of applications including spatial, industrial and medical robotics. Simulates and analyzes motions of multi-link mechanisms in the MATLAB programming environment. Design and build robots with interesting mechanisms and mechatronics elements as part of group projects. Studies machining, assembly, mechatronics and programming through the projects. Three lecture hours a week for one semester. Mechanical Engineering 380R and 397 (Topic: Robot Mechanism Design) may not both be counted. Prerequisite: Graduate Standing.

M E 381M. Statistical Methods for Process Control Manufacturing.

Restricted to Option III Mechanical Engineering Master's degree students. Covers fundamental methods for statistical monitoring of processes, including Shewhart control charts, control charts for individual measurements, CUSUM charts and attribute control charts. Explores the design of experiments, including the statistical evaluation of main and interaction effects, as well as intelligent experimentation through reduced factorial experimental design. Outlines DOE-based search techniques for surface response based design optimization. Offers advanced research in model based and active process control in highly flexible and sophisticated manufacturing systems, such as semiconductor manufacturing lithography of flexible automotive assembly lines. Three lecture hours a week for one semester. Prerequisite: Graduate standing and admission to the Executive ME program.

M E 381P. Dynamics of Fluids.

Detailed study of fluid dynamics, boundary layer phenomena, and incompressible flows. Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing.

Topic 1: Fundamentals of Incompressible Flow. Fundamentals. Kinematic and dynamic equations for compressible viscous flow, incompressible flow criteria, viscous flow patterns, and solution methods.
Topic 2: Compressible Flow and Turbomachinery. Two-dimensional flow at subsonic and supersonic Mach numbers, method of characteristics, shock tubes, oblique shocks, wave interactions.
Topic 3: Dynamics of Turbulent Flow. Fundamentals of turbulence, including scaling, transport, and kinetic energy of turbulence; wakes, jets; wall-bounded flows; spectrum of turbulence.
Topic 4: Multiscale Flow and Transport Phenomena. Fundamentals of flow and transport phenomena in multiscale systems, including momentum, energy, and mass transport phenomena at the microscale; surface tension (capillarity); electrokinetics; micro-scale transport in porous media; multi-phase flow; rheology; and complex fluids.
Topic 5: Applications of Incompressible Flow. Dynamics of vorticity, inviscid flow; boundary layer theory and computational techniques, linear stability theory for parallel flow, flow at moderate Reynolds number.

M E 381Q. Thermodynamics.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing, and Mechanical Engineering 326 or the equivalent.

Topic 1: Advanced Thermodynamics. Development of macroscopic thermodynamics from basic physical relationships; introduction to the thermodynamics of mixtures.
Topic 4: Molecular Gas Dynamics. Same as Aerospace Engineering 382R (Topic 6). Kinetic theory, chemical thermodynamics, statistical mechanics. Applications: equilibrium gas properties, chemical kinetics, interaction of matter with radiation, rarefied gas dynamics. Additional prerequisite: Consent of instructor

M E 381R. Heat Transfer and Rate Processes.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing, and Mechanical Engineering 339 or the equivalent.

Topic 1: Advanced Conductive Heat Transfer. Modeling approaches for composite systems; phase change in conduction-dominant heat transfer systems; analysis of complex source terms in conduction systems; conduction physics at material interfaces; coupled thermo-mechanical response in conduction systems; and solution techniques for multidimensional, unsteady conduction phenomena.
Topic 2: Advanced Convective Heat and Mass Transfer. Fundamental study of momentum, energy, and mass transport in convective systems in laminar and turbulent regimes, and several flow configurations.
Topic 3: Radiation Heat Transfer. Thermal radiation, blackbody properties, surface properties, radiant exchange, absorbing and emitting media, combined modes.
Topic 4: Fundamentals of Heat and Mass Transfer. Fundamentals of conduction, convective heat transfer, diffusive and convective mass transfer, thermal radiative exchange.
Topic 5: Radiation in Participating Media. Methods for treating thermal radiation in absorbing, transmitting, and scattering media.
Topic 6: Multiphase Flow and Heat Transfer. Heat, mass, and momentum transfer in multi-phase flow systems: flows with particles, drops and bubbles, boiling, condensation, and absorption.
Topic 7: Nanoscale Energy Transport and Conversion. Nanoscale transport phenomena and energy conversion processes. Parallel theoretical treatment of transport and conversion processes of electrons, phonons, photons, and molecules in various applications including photovoltaic and thermoelectric energy conversions, microelectronics, nanomaterials, and laser materials processing.

M E 382N. Computational Fluid Dynamics.

Numerical analysis applied to fluid flow and heat transfer problems. Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing.

Topic 1: Introduction to Computational Fluid Dynamics. Applied numerical analysis, including solution of linear algebraic equations and ordinary and partial differential equations; modeling of physical processes, including fluid flow and heat and mass transfer; use of general-purpose computer codes, including commercial computational fluid dynamics software. Additional prerequisite: Mechanical Engineering 339 or the equivalent.
Topic 2: Computational Methods for Thermal Fluid Systems. Introduction to the use of computational tools in the analysis of thermal-fluid systems, with particular emphasis on verification of results and error analysis. Included are interpolation, differentiation, quadrature, solution of linear and non-linear equations, optimization, differential equations and statistics. Additional prerequisite: Mathematics 427K or the equivalent.

M E 382P. Topics in Experimental Thermal/Fluid Systems.

Use of modern experimental techniques and instrumentation in the thermal/fluid sciences. Two lecture hours and three laboratory hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing.

Topic 1: Advanced Experimental Methods for Thermal/Fluid Systems. Design of experiments; fundamentals of electronic signal processing and optics; advanced experimental techniques, including flow measurements with laser-Doppler velocimetry, particle image velocimetry, and hot-wire anemometry; and thermal measurements with infrared cameras and thermocouples.

Topic 2: Optics and Lasers. Fundamentals of geometric and physical optics; interaction of light with matter; spectroscopy; and laser and electro-optics applications.

M E 382Q. Design of Thermal and Fluid Systems.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing, and Mechanical Engineering 339 or the equivalent.

Topic 2: Solar Energy System Design. Solar radiation, solar collectors, storage, and system analysis and design. Application to both thermal and photovoltaic systems.
Topic 3: Advanced Thermo-Fluid Systems. Project-based course addressing the design and analysis of systems in which thermal and fluid processes are central to function and performance. Advanced topics including transient system analysis, multicomponent nonreacting and reacting gas mixtures, phase change phenomena, and design principles based on entropy generation minimization are covered in the context of specific thermal-fluid applications.
Topic 4: Energy Technology and Policy. Multidisciplinary overview of energy technologies, fuels, environmental impacts, and public policies. Quantitative engineering analysis in energy, including the differences among fuels and energy technologies, the electricity sector, liquid fuels, conventional fuels, renewable fuels, impacts on the environment, basics of atmospheric chemistry, and water use for power plant cooling. Energy policy and the societal aspects of energy, such as culture, economics, war, and international affairs, are covered.

M E 382R. Topics in Combustion.

Fundamentals of combustion science, technology, and engineering. Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

Topic 1: Fundamentals of Combustion. Combustion phenomena are examined from a fundamental perspective. Topics include equilibrium phenomena, chemical kinetics, explosions, detonations, and premixed and diffusion flames. Additional prerequisite: Knowledge of computer programming or the use of public domain codes.
Topic 2: Chemical Kinetics. The theory of combustion chemistry. Issues include physics of molecular interactions, the explosion peninsula, elementary reaction schemes, reduced reaction schemes, and global chemistry.
Topic 5: Advanced Combustion. Presentation and analysis of multi-component and reacting conservation equations; examination of the theory of laminar flames (premixed and nonpremixed) using asymptotic methods; detailing of ignition and extinction phenomena; discussion of flame response to transport and flow modifications; and approaches to analyzing turbulent premixed and nonpremixed flames.
Topic 6: Combustion Engine Processes. Principles of internal combustion engines, fuels, carburetion, combustion, exhaust emissions, knock, fuel injection, and factors affecting performance.

M E 382T. Fire Science.

Analysis of dynamics and consequences of fire in structures. Topics include combustion thermochemistry, premixed and diffusion flames, fluid mechanics of fire, human tenability in burning structures, computer modeling of fires. Three lecture hours a week for one semester. Mechanical Engineering 382R (Topic: Fire Science) and 382T may not both be counted. Prerequisite: Graduate standing, and Mechanical Engineering 326, 330, and 339, or their equivalents.

M E 383D. Theory and Design for Mechanical Sensing and Measurements.

Explore fundamental aspects of measurement systems: sensing, signal processing, experimental methods, uncertainty analysis, detection, and estimation. Three lecture hours a week for one semester. Mechanical Engineering 383D and 397 (Topic: Thry/Dsgn of Mech Measurement) may not both be counted. Prerequisite: Graduate standing, undergraduate mechatronics, and statistics.

M E 383M. Heat Transfer in Industrial Systems.

Restricted to Option III Mechanical Engineering Master's degree students. Provides understanding of heat transfer physics and the tools to analyze a wide range of industrially relevant heat transfer problems. Analyzes heat transfer systems associated with a diversity of industrial applications, as well as how to use order of magnitude analysis to simplify complex problems and solution techniques for the three modes of heat transfer. Three lecture hours a week for one semester. Prerequisite: Graduate standing.

M E 383Q. Analysis of Mechanical Systems.

Detailed studies in the characteristics of mechanical systems. Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing.

Topic 1: Vibrations. Formulation of discrete and continuous models for mechanical systems in vibration; modal analysis; analytical solution methods for constant property linear systems; numerical solution methods.
Topic 2: Dynamics of Mechanical Systems. Advanced dynamics, including Newton-Euler, Lagrange, and Hamilton's principles; gyroscopic effects in mechanical systems; analysis of stability of systems; continuous bodies; introduction to Hamilton-Jacobi.
Topic 4: Modeling of Physical Systems. Development of models for mechanical, electrical, fluid, thermal, and chemical systems; circuit techniques; bond graphs; energy and variational methods; hardware examples.
Topic 5: Wave Propagation. Fundamentals of wave propagation; transverse waves on strings and membranes; compressional, torsional, and flexural waves in rods and plates; longitudinal, shear, and surface waves in elastic media; tube waves; and water waves.
Topic 6: Fourier and Spectral Analysis in Dynamic Systems. Fourier transformations (series, integrals, fast Fourier transforms) and their relationships. Sampling, aliasing, convolution, correlation, leakage, windowing, power spectra, frequency response functions, and coherence functions in one-dimensional digital signal processing. Cepstrum analysis, Hilbert transforms. Experimental techniques and applications include modal analysis, mechanical signature analysis, and path identification. Additional prerequisite: Consent of instructor.
Topic 8: Digital Signal Processing. Sampling and quantizing processes; analog/digital and digital/analog conversion; digital Fourier analysis, including fast Fourier transform; z transform; design of finite impulse response and infinite impulse response digital filters.
Topic 9: Applied Intelligence for Engineers. Fundamental concepts of artificial neural systems; architecture, paradigms, topology, and learning algorithms. Introduction to the most popular networks and to their selection for engineering applications.
Topic 10: Modeling and Simulations of Multienergy Systems. Methods for modeling and simulation of multienergy systems. Detailed study of applications in electromechanical systems, fluid power, chemical and biological processes, optimal control, and other areas of interest to the class.

M E 383S. Lubrication, Wear, and Bearing Technology.

Theory of friction and wear; design of bearing systems, including hydrodynamic, rheodynamic, and direct contact devices. Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

Topic 1: Friction and Wear of Materials. Theories of friction, theories of wear (adhesion, delamination), pitting, spalling, fretting, and galvanic corrosion.

M E 384D. Intermediate Dynamics.

Focus on efficient formulation and solution of equations of motion for complex 3D multi-body mechanical systems. Explore the formulation of the dynamical equations of motion using Kane's Method and use of symbolic and numerical simulation techniques to solve these equations. Three lecture hours a week for one semester. Mechanical Engineering 384D and 397 (Topic: Intermediate Dynamics) may not both be counted. Prerequisite: Graduate standing.

M E 384E. Electromechanics.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

M E 384M. Fluid Mechanics in Industrial Processes.

Restricted to Option III Mechanical Engineering Master's degree students. Offers practicing engineers and technology managers a comprehensive treatment of various fluid mechanics topics. Explores fluid flow and related phenomena in multiple application spaces. Benefit the design and analyses of various fluid-based systems. Three lecture hours a week for one semester. Prerequisite: Graduate standing and admission to the Executive ME program.

M E 384N. Acoustics.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

Topic 1: Acoustics I. Same as Electrical and Computer Engineering 384N (Topic 1). Plane waves in fluids; transient and steady-state reflection and transmission; lumped elements; refraction; strings, membranes, and rooms; horns; ray acoustics; absorption and dispersion. Only one of the following may be counted: Electrical and Computer Engineering 384N (Topic 1), Electrical Engineering 384N (Topic 1), Mechanical Engineering 384N (Topic 1).
Topic 2: Acoustics II. Same as Electrical and Computer Engineering 384N (Topic 2). Spherical and cylindrical waves, radiation and scattering, multipole expansions, Green's functions, waveguides, sound beams, Fourier acoustics, Kirchhoff theory of diffraction, and arrays. Only one of the following may be counted: Electrical and Computer Engineering 384N (Topic 2), Electrical Engineering 384N (Topic 2), Mechanical Engineering 384N (Topic 2).
Topic 3: Electromechanical Transducers. Same as Electrical and Computer Engineering 384N (Topic 3). Modeling, analysis, and design of transducers for reception and transmission of acoustic and vibration signals; dynamics of coupled electrical, mechanical, and acoustical systems; and the effects of transducer characteristics on fidelity and efficiency of transduction. Only one of the following may be counted: Electrical and Computer Engineering 384N (Topic 3), Electrical Engineering 384N (Topic 3), Mechanical Engineering 384N (Topic 3).
Topic 4: Nonlinear Acoustics. Same as Electrical and Computer Engineering 384N (Topic 4). Waveform distortion and shock formation, harmonic generation and spectral interactions, effects of absorption and dispersion, parametric arrays, Rankine-Hugoniot relations, weak shock theory, numerical modeling, radiation pressure, and acoustic streaming. Only one of the following may be counted: Electrical and Computer Engineering 384N (Topic 4), Electrical Engineering 384N (Topic 4), Mechanical Engineering 384N (Topic 4).
Topic 5: Underwater Acoustics. Same as Electrical and Computer Engineering 384N (Topic 5). Acoustic properties of the ocean; acoustic propagation, reflection, reverberation, scattering and target strength; ocean noise; introduction to array and signal processing; basics of sonar design. Only one of the following may be counted: Electrical and Computer Engineering 384N (Topic 5), Electrical Engineering 384N (Topic 5), Mechanical Engineering 384N (Topic 5).
Topic 6: Architectural Acoustics. Same as Electrical and Computer Engineering 384N (Topic 6). Human perception of sound, principles of room acoustics, sound-absorptive materials, transmission between rooms, and acoustical design of enclosed spaces. Only one of the following may be counted: Electrical and Computer Engineering 384N (Topic 6), Electrical Engineering 384N (Topic 6), Mechanical Engineering 384N (Topic 6).
Topic 7: Ultrasonics. Same as Electrical and Computer Engineering 384N (Topic 7). Acoustic wave propagation in fluids, elastic solids, and tissue; transducers, arrays, and beamforming; nondestructive evaluation; and acoustical imaging. Only one of the following may be counted: Electrical and Computer Engineering 384N (Topic 7), Electrical Engineering 384N (Topic 7), Mechanical Engineering 384N (Topic 7).
Topic 8: Wave Phenomena. Same as Electrical and Computer Engineering 384N (Topic 8). Fourier acoustics and angular spectra; nearfield acoustical holography; Fraunhofer, Fresnel, and parabolic approximations; sound beams; Green's functions; Born approximation; propagation and scattering in moving, periodic, and random media. Only one of the following may be counted Electrical and Computer Engineering 384N (Topic 8), Electrical Engineering 384N (Topic 8), Mechanical Engineering 384N (Topic 8), 397 (Topic: Wave Phenomena).
Topic 9: Acoustic Metamaterials. Same as Electrical and Computer Engineering 384N (Topic 9). Examine wave propagation in heterogeneous media displaying nonclassical effective properties. Introduction to effective medium theories including fundamental limits on effective properties, transmission and scattering matrices, waves in periodic media, localized resonance, and transformation acoustics. Only one of the following may be counted: Mechanical Engineering 384N (Topic 9), 397 (Topic: Acoustic Metamaterials), Electrical and Computer Engineering 384N (Topic 9).

M E 384Q. Design of Control Systems.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing.

Topic 1: Introduction to Modern Control. State variable methods, eigenvalues, and response modes; controllability, observability, and stability; calculus of variations; optimal control; Pontryagin maximum principle; control of regulator and tracking servomechanisms; Hamilton-Jacobi, dynamic programming; deterministic observers, Kalman filter; discrete and continuous time.
Topic 2: Nonlinear Control Systems. State space formulation; stability criteria; Liapunov functions; describing functions; signal stabilization; Popov and circle criteria for design.
Topic 3: Time-Series Modeling, Analysis, and Control. Same as Operations Research and Industrial Engineering 390R (Topic 3: Time-Series Modeling, Analysis, and Control). Methods for analytical modeling, analysis, prediction, and control of linear, stationary time series. Includes examples of advanced research in nonstationary time-series modeling and applications in manufacturing, financial engineering, geosciences, and other areas. Students complete a project on a topic of their choice. Additional prerequisite: Graduate standing, and Mechanical Engineering 364L or the equivalent, an undergraduate calculus-based course in probability and statistics or consent of instructor.
Topic 4: Automatic Control System Design. Examine feedback principles; control components; industrial compensators; Routh, Nyquist, Bode, and root locus methods; controller design; continuous

and discrete time control. Mechanical Engineering 384Q (Topic 4) and Mechanical Engineering 397 (Topic: Automatic Control Sys Design) may not both be counted.
Topic 7: Stochastic Systems, Estimation, and Control. Probability and random variables; filtering theory; stochastic calculus; stochastic control; engineering applications; linear and nonlinear systems; spectral techniques.
Topic 8: Propulsion Systems and Controls. Study principles, modeling, analysis, system integration, control, and diagnosis of diverse ground vehicle propulsion and driveline systems. Three lecture hours a week for one semester. Mechanical Engineering 384Q (Topic 8) and Mechanical Engineering 397 (Topic: Propulsion Systems/ Control) may not both be counted.
Topic 9: Advanced Vehicle Powertrain Systems and Control. Explore the basic concept of vehicle powertrain systems and controller design, and discuss state of the art vehicle powertrain development. Examine modeling of system dynamics, and applying modern control strategies to achieve the desired system performance. Mechanical Engineering 384Q (Topic 9) and 397 (Topic: Adv Vehicle Powertrn Sys/ Cont) may not both be counted.
Topic 10: Real-Time Control System Labs. Conduct design, implementation, hands-on experiments, and analysis of real-time estimation and control algorithms for physical systems. Three lecture hours a week for one semester. Mechanical Engineering 384Q (Topic 10) and Mechanical Engineering 397 (Topic: Real-Time Control Sys Labs) may not both be counted.
Topic 11: Estimation and Control of Ground Vehicle Systems. Examine advanced control and estimation systems for ground vehicle propulsion, chassis, and automation systems. Discuss combinations of physical insight into ground vehicle systems with control and estimation methods. Mechanical Engineering 384Q (Topic 11) and 397 (Topic: Est and Contl Sys for Grnd Veh) may not both be counted.
Topic 12: Digital Control. Explore the concepts of sampling and discrete-time signals/systems; analysis of discrete-time systems; design of discrete-time controllers, including input/output approaches, polynomial methods, state space techniques, and linear quadratic optimal control design. Examine understanding of computer controlled systems, construction of discrete-time models, analysis of the open loop and closed-loop behavior, and design of digital control algorithms. Mechanical Engineering 384Q (Topic 12) and 397 (Topic: Digital Control) may not both be counted.

M E 384R. Robotics.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing.

Topic 1: Robotics and Automation. Component technologies for precision machines based on dynamic modeling and motion programming: cams, linkages, planar manipulators.
Topic 2: Design of Smart Mechanisms. Design of reprogrammable multiple-degree-of-freedom architectures. The course addresses various mechanical configurations and stresses the integrated design approach to sensing/actuation/control architecture and control software. Includes design project.
Topic 3: Advanced Dynamics of Robotic Systems. Treatment in depth of the dynamics of robotic systems. Discussion of modeling, analysis, and control of conventional serial robots, in-parallel manipulators, dual arms, and legged locomotion systems.
Topic 4: Geometry of Mechanisms and Robots. Advanced topics in theoretical kinematics geometry: applications of screw system theory to the study of motion and force fields in spatial mechanisms and robotic systems; analytical and numerical schemes associated with kinematics geometry.
Topic 5: Planar Mechanism Synthesis. Design of planar mechanisms for applications that require rigid body guidance, function generation, and path generation. Graphical and analytical techniques. Computer-aided design projects.
Topic 7: Brain, Body, and Robotics. Examine computational models of brain control of human movement. Explore the roles of sensors, actuators, and neural circuits for biological movement control from an engineering perspective. Study current approaches to robotic and mechatronic devices that support and enhance human movements. Develop and test prototypes for robot modules that interact with the human body while studying the latest literature in neuromuscular controls, neuromotor recovery, and design and control of rehabilitation robots. Three lecture hours a week for one semester. Mechanical Engineering 384R (Topic 7) and 397 (Topic: Brain, Body, and Robotics) may not both be counted.
Topic 8: Algorithms for Sensor-Based Robotics. Use advanced mathematical concepts in linear algebra and optimization to develop applied algorithms for robotic systems utilizing various imaging modalities and sensors. Explore all phases of kinematics/dynamics modeling, preparation, motion planning, and execution. Examine examples of such algorithms in various areas including, but not limited to, robotic surgery, mobile robotics, manipulation, and human-machine interaction systems. Mechanical Engineering 384R (Topic 8) and 397 (Topic: Algrthms Snsr-Based Robotcs) may not both be counted.
Topic 9: Haptics and Teleoperated Systems. Examine theory, analysis, and application of a variety of haptic and teleoperated systems, particularly in robotics and consumer electronics. Mechanical Engineering 384R (Topic 9) and 397 (Topic: Haptic and Teleoperated Sys) may not both be counted.

M E 385J. Topics in Biomedical Engineering.

Three lecture hours a week for one semester, or as required by the topic. May be repeated for credit when the topics vary. Prerequisite: Graduate standing in engineering and consent of instructor.

Topic 1: Cell and Tissue Anatomy and Physiology for Engineers. An overview of cellular biology, including functional cellular anatomy, DNA replication and the cell cycle, protein synthesis, membrane structure and function, energy metabolism, cellular homeostasis, and cell repair and death; and functional anatomy and physiology of the basic tissues.
Topic 2: Organ System Anatomy, Physiology, and Pathology for Engineers. The functional anatomy and physiology of the major human organ systems; representative pathologic disorders associated with these organs. An overview of general pathologic processes, with emphasis on the influences of normal and abnormal organ anatomy, physiology, and disease on the definition and solution of biomedical engineering problems. Two lecture hours and one three-hour laboratory a week for one semester. Additional prerequisite: Mechanical Engineering 385J (Topic 1) or the equivalent.
Topic 3: Bioelectric Phenomena. Examines the physiological bases of bioelectricity and the techniques required to record bioelectric phenomena both intracellularly and extracellularly; the representation of bioelectric activity by equivalent dipoles and the volume conductor fields produced.
Topic 5: Cardiovascular Dynamics. Anatomy, physiology, pathophysiology, and dynamics of the cardiovascular system, with emphasis on the design and application of electrical and mechanical devices for cardiac intervention.
Topic 9: Laser-Tissue Interaction: Thermal. The thermal response of random media in interaction with laser irradiation. Calculation of the rate of heat production caused by direct absorption of the laser light, thermal damage, and ablation.
Topic 10: Biomedical Application of Transport Phenomena. Investigates radioisotopic methods for biological transport, including theory and experiments. Investigates artificial organ systems with

clinical laboratory experiments to augment theory presented in lectures.
Topic 11: Biomedical Engineering Hospital Interfaces. Students gain firsthand knowledge of the instrumentation, procedures, and organization of a modern hospital. Class sessions are held in the different clinical services and laboratories of the hospital.
Topic 12: Biomedical Heat Transfer. Heat transfer in biological tissue; determination of thermodynamic and transport properties of tissue; thermal effects of blood perfusion; cryobiology; numerical modeling methods; clinical applications. Additional prerequisite: Mechanical Engineering 339, Chemical Engineering 319 (or 353), or the equivalent; consent of instructor.
Topic 13: Molecular Recognition in Biology and Biotechnology.
Topic 15: Biosignal Analysis. Theory and classification of biological signals such as EEG, EKG, and EMG. Data acquisition and analysis procedures for biological signals, including computer applications.
Topic 16: Laser-Tissue Interaction: Optical. The optical behavior of random media such as tissue in interaction with laser irradiation. Approximate transport equation methods to predict the absorption and scattering parameters of laser light inside tissue. Port-wine stain treatment; cancer treatment by photochemotherapy; and cardiovascular applications.
Topic 17: Biomedical Instrumentation II: Real-Time Computer-Based Systems. Design, testing, patient safety, electrical noise, biomedical measurement transducers, therapeutics, instrumentation electronics, and microcomputer interfaces. Several case studies are presented. Four structured laboratories and an individual project laboratory.
Topic 18: Biomedical Image Processing. Physical principles and signal processing techniques used in thermographic, ultrasonic, and radiographic imaging, including image reconstruction from projections such as CT scanning, MRI, and millimeter wave determination of temperature profiles. Additional prerequisite: Electrical Engineering 371R.
Topic 20: Network Thermodynamics in Biophysics. Modeling and simulation methods for nonlinear biological processes, including coupling across multienergy domains; practical implementation by bond graph techniques. Additional prerequisite: Mechanical Engineering 344 or consent of instructor.
Topic 23: Optical Spectroscopy. Measurement and interpretation of spectra: steady-state and time-resolved absorption, fluorescence, phosphorescence, and Raman spectroscopy in the ultraviolet, visible, and infrared portions of the spectrum.
Topic 24: Rehabilitation Engineering. Same as Biomedical Engineering 384J (Topic 8). Explores use of robotic devices in physical therapy for neuromuscular injury. Clinicians lecture each week on a specific malady, followed by critical review of the literature of that malady from the perspective of rehabilitation engineering. Shadows therapists and develops a prototype of a device for therapy, assistance or diagnosis of patients, or conducts an experiment to test a hypothesis in the field using a device. Three lecture hours a week for one semester. Only one of the following may be counted: Biomedical Engineering 381J (Topic: Rehabilitation Engineering), 384J (Topic 8), Mechanical Engineering 385J (Topic 24), 397 (Topic: Rehabilitation Engineering).
Topic 26: Therapeutic Heating. Engineering aspects of electromagnetic fields that have therapeutic applications: diathermy (short wave, microwave, and ultrasound), electrosurgery (thermal damage processes), stimulation of excitable tissue, and electrical safety.
Topic 27: The Biotechnology Revolution and Engineering Ethics. The history and status of genetic engineering; potential applications in medicine, agriculture, and industry; ethical and social issues surrounding the engineering of biological organisms; ethics in engineering practice in physical and biological realms.
Topic 28: Noninvasive Optical Tomography. Basic principles of optical tomographic imaging of biological materials for diagnostic or therapeutic applications. Optical-based tomographic imaging techniques including photothermal, photoacoustic, and coherent methodologies.
Topic 29: Transport Processes in Biological Systems. Introduction to engineering analysis of transport phenomena in living systems, including fluid flow, heat transfer, pharmacokinetics, and membrane fluxes with clinical applications.
Topic 30: Introduction to Biomechanics. Modeling and simulation of human movement; neuromuscular control; computer applications; introduction to experimental techniques. Three lecture hours and one laboratory hour a week for one semester.
Topic 31: Biomedical Instrumentation I. Application of electrical engineering techniques to analysis and instrumentation in biological sciences: pressure, flow, temperature measurement; bioelectrical signals; pacemakers; ultrasonics; electrical safety; electrotherapeutics.
Topic 32: Projects in Biomedical Engineering. An in-depth examination of selected topics, such as optical and thermal properties of laser interaction with tissue; measurement of perfusion in the microvascular system; diagnostic imaging; interaction of living systems with electromagnetic fields; robotic surgical tools; ophthalmic instrumentation; noninvasive cardiovascular measurements. Three lecture hours and six laboratory hours a week for one semester. Additional prerequisite: Mechanical Engineering 385J (Topic 31).
Topic 33: Neurophysiology/Prosthesis Design. The structure and function of the human brain. Discussion of selected neurological diseases in conjunction with normal neurophysiology. Study of neuroprosthesis treatments and design philosophy, functional neural stimulation, and functional muscular stimulation.
Topic 34: Biopolymers and Drug/Gene Delivery. Introduction to different classes of biopolymers. Biodegradability and biocompatibility. Interaction of cells and tissues with polymers and polymeric implants; immunology of biomaterials. Applications of polymers in medicine and biology. Gene therapy and generic immunization. The use of biopolymers and drug/gene delivery in organ regeneration and tissue engineering.
Topic 35: Rehabilitation Robotics and Engineering. Explores the use of robotic devices to support the strength of patients and therapists, quantitatively diagnose impairment, and augment function. Critically review the literature in rehabilitation engineering from both robotics and scientific perspectives. Students also shadow therapists and develop a prototype of a device for therapy, assistance or diagnosis of patients, or conduct an experiment to test a hypothesis in the field using a device.
Topic 36: Modeling and Simulation of Human Movement. Examine a synthesis of neuromusculoskeletal properties and interactions with the environment to construct detailed musculoskeletal models and computer simulations that allow for the investigation of various aspects of human movement. Explore a review of rigid-body dynamics, inverse and forward dynamic analyses, muscle physiology and models, musculoskeletal anthropometrics, muscle induced acceleration and segment power analyses, contact models, optimal control, muscle force distribution solutions, and simulation applications. Mechanical Engineering 385J (Topic 22) and 385J (Topic 36) may not both be counted. Additional prerequisite: An undergraduate dynamics course, an introductory biomechanics of human movement course, and a computer programming course.

M E 385M. Applied Thermodynamics.

Restricted to Option III Mechanical Engineering Master's degree students. Addresses the design and analysis of systems in which thermodynamic processes are central to function and performance.

Reviews fundamental thermodynamic concepts, such as enthalpy, entropy, exergy, 1st & 2nd law, psychrometrics and combustion. Discusses practical topics, such as system-level thermodynamic processes for automotive engines, power plants, renewable energy production and HVAC systems. Gives real-world examples to cultivate skills of solving problems with basic knowledge of thermodynamics. Three lecture hours a week for one semester. Prerequisite: Graduate standing and admission to the Executive ME program.

M E 386M. Modeling, Simulation, and Control of Physical Systems.

Restricted to Option III Mechanical Engineering Master's degree students. Reviews principles used to understand and model physical systems and introduces methods for building mathematical and simulation models of engineering systems. Emphasis on the development of dynamic system models for predicting the behavior or performance of systems, models for efficient data reduction or test development, models for design, and the role of models in control development. Bond graph methods are introduced especially for analysis of systems having combinations of mechanical, electrical, magnetic, electromechanical, fluid, and thermodynamic effects. Covers the role and application of physical models in development and design of feedback controllers and estimation methods. Three lecture hours a week for one semester. Prerequisite: Graduate standing and admission to the Executive ME program.

M E 386P. Materials Science: Fundamentals.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

Topic 1: Introduction to Phase Transformations. Same as Materials Science and Engineering 386P (Topic 1). Basics of crystal structures and phase diagrams; diffusion; solidification; solid-state phase transformations. Mechanical Engineering 386P (Topic 1) and Materials Science and Engineering 386P (Topic 1) may not both be counted.
Topic 2: Mechanical Behavior of Materials. Same as Materials Science and Engineering 386P (Topic 2). Elastic deformation; viscoelasticity; yielding, plastic flow, plastic instability; strengthening mechanisms; fracture, fatigue, creep; significance of mechanical properties tests. Microstructural mechanisms and macroscopic behavior of metals, polymers, ceramics, and composites. Mechanical Engineering 386P (Topic 2) and Materials Science and Engineering 386P (Topic 2) may not both be counted.
Topic 3: Introduction to Thermodynamics of Materials. Same as Materials Science and Engineering 386P (Topic 3). Thermodynamic properties; reactions and chemical equilibrium in gases; solutions, phase equilibria, phase diagrams, reaction equilibria; surfaces and interfaces; point defects in crystals. Mechanical Engineering 386P (Topic 3) and Materials Science and Engineering 386P (Topic 3) may not both be counted.
Topic 4: Introduction to Solid-State Properties of Materials. Same as Electrical and Computer Engineering 396V (Topic 5) and Materials Science and Engineering 386P (Topic 4). Introduction to the electronic, magnetic, and optical properties of materials. Solid-state properties of metals, semiconductors, and ceramics; fundamental concepts needed for the description of these properties, using an introductory-level description of the electronic structure of solids. Only one of the following may be counted: Electrical Engineering 396V (Topic 5), Electrical and Computer Engineering 396V (Topic 5), Mechanical Engineering 386P (Topic 4), Materials Science and Engineering 386P (Topic 4). Additional prerequisite: Graduate standing and consent of instructor.
Topic 5: Structure of Materials. Same as Materials Science and Engineering 386P (Topic 5). Essential crystallography of lattices and structures; symmetry; elements of diffraction and reciprocal lattices; point, line, and surface defects in crystals; crystalline interfaces; noncrystalline materials; polymers; glasses. Mechanical Engineering 386P (Topic 5) and Materials Science and Engineering 386P (Topic 5) may not both be counted.
Topic 6: Kinetic Processes in Materials. Review of irreversible thermodynamics and rate of entropy production to define the equilibrium state of a system; derivation of mathematical expressions to describe relaxation from a constrained state to equilibrium; diffusional processes in materials; calculation of diffusion coefficients from solid-state properties; dislocations and interfaces; kinetics of phase transformations.

M E 386Q. Materials Science: Structure and Properties.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

Topic 1: Theory of Materials. Periodic behavior and the periodic table; historical approach to the principles of crystal structure; complex alloy phases; some aspects of phase stability.
Topic 2: Phase Diagrams. Phase equilibria in materials systems; systematic treatment of unary, binary, and ternary phase diagrams.
Topic 3: Fracture of Structural Materials. Microscopic and macroscopic aspects of ductile and brittle fracture; fracture mechanisms and fracture prevention.
Topic 4: Physical Metallurgy of Steels. The iron-carbon system; transformations and structures of steels; properties of pearlite, bainite, and martensite; tempering; hardenability and the effect of alloying elements.
Topic 7: Composite Materials. The theory of structural composite materials, their physical and mechanical properties; processing associated with metal-ceramic-polymer composites. Additional prerequisite: Mechanical Engineering 260K (or 360K) or the equivalent, Mechanical Engineering 378K or the equivalent, or consent of instructor.
Topic 9: Crystalline and Composite Anisotropy. Mathematical analysis of anisotropic materials, including single crystals, laminate composites, and deformation-hardened metals. Topics include thermal and electrical conductivity, diffusivity, thermal expansion, elasticity, and yielding.
Topic 10: High-Temperature Materials. Theory and practice in use of materials for high-temperature structural applications; case-study considerations of actual problems and requirements; interactive process-microstructure-property relationships in materials development and applications of superalloys, intermetallics, composites, and ceramics; prospective trends.
Topic 11: Electroceramics. Bonding; crystal structures; defects; phase diagrams; glass ceramics; electrical, dielectric, magnetic, and optical ceramics.
Topic 14: Electrochemical Energy Materials. Electrochemical cells; principles of electrochemical power sources; materials for rechargeable and nonrechargeable batteries, fuel cells, and electrochemical capacitors.
Topic 15: Computational Materials Science and Engineering. Examine theory and a hands-on tutorial for atomistic modeling of materials. Mechanical Engineering 386Q (Topic 15) and 397 (Topic: Computatnl Matl Sci and Eng) may not both be counted.
Topic 16: Application Perspectives of Nanotechnology. Subjects include standard top-down and the state-of-the-art bottom-up nanofabrication, manipulation, and assembling techniques, commonly used characterization instruments; applications of nanomaterials in biochemical sensing based on electric, optical,

magnetic and mechanical effects; flexible nanoelectronics; nanomanipulation and nanorobotics, applications of nanomaterials in Nanoelectromechanical System (NEMS) devices, bioMEMS, and microfluidics. Emphasis on oral and written scientific communication skills. Mechanical Engineering 386Q (Topic: Application Perspectives of Nanotechnology) and 386Q (Topic 16) may not both be counted. Additional prerequisite: Graduate standing and consent of instructor.
Topic 17: Failure Analysis. Introduction to methodology of analyzing failures of engineering parts and devices. Explores a broad range of analysis, but the focus is on understanding fractography and relating this back to material and mechanics relevant to failure to determine the likely root cause(s). Lectures are primarily based on case studies and are supplemented by two hands-on class projects, one performed individually and the other larger project performed as a team project. Three lecture hours a week for one semester. Mechanical Engineering 386Q.17 and 397 (Topic: Failure Analysis) may not both be counted. Additional prerequisite: Graduate standing.
Topic 18: Advanced Numerical Methods: Theory and Practice. Apply the theory behind numerical simulation, optimization of electrochemical engineering, and other engineering models described by nonlinear differential, differential-algebraic, and partial differential equations. Explore a self-contained, fundamental and practical approach to the theory, algorithm development, and implementation relevant to engineering systems, in particular for electrochemical systems, and batteries. Mechanical Engineering 386Q (Topic 18) and Mechanical Engineering 397 (Topic: Adv Numrl Mthds-Theor/Prac) may not both be counted.
Topic 19: Nanotechnology for Sustainable Energy. Explore an overview of emerging nanotechnology and how nanoscience can critically impact many energy technologies (from energy harvesting, conversion, to storage). Examine various types of energy devices covered, including solar cell, solar fuel, piezoelectrics, thermoelectrics, battery, supercapacitor, and fuel cell. Discuss basic device principles, current technology status, and new opportunities of nanotechnology for energy-related applications. Mechanical Engineering 386Q (Topic 19) and Mechanical Engineering 397 (Topic: Nanotech for Sustainbl Enrg) may not both be counted.
Topic 20: Polymer Nanocomposites. Explore an overview of key technologies and processes in polymer nanocomposites. Examine a different property (structural, mechanical, thermal, flammability, ablation, and electrical) and relevant commercial and industrial applications. Discuss examples for a wide variety of usage for spacecraft and defense vehicles, medical and dental implants, flame-retardant and conductive polymers for additive manufacturing, and fire-resistant woven and nonwoven fabrics. Mechanical Engineering 386Q (Topic 20) and Mechanical Engineering 397 (Topic: Polymer Nanocomposites) may not both be counted.
Topic 23: Structural Ceramics. Explore microstructure-mechanical property relationships in ceramics; principles of fracture mechanics, and static and dynamic fracture; static and cyclic fatigue; high-temperature behavior; strengthening and toughening mechanisms in monolithic ceramics; and particulate and fibrous ceramic composites. Mechanical Engineering 386Q (Topic 13) and 386Q (Topic 23) may not both be counted.

M E 386R. Materials Science: Physical and Electronic Properties.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

Topic 1: Localized versus Itinerant Electrons in Solids. Same as Electrical and Computer Engineering 396K (Topic 9). Description of electrons, from free atoms to crystals; band theory contrasted with crystal-field theory; evolution of electronic properties on passing from magnetic insulators to normal metals, from ionic to covalent solids, from single-valent compounds to mixed-valent systems; electron-lattice interactions and phase transitions; many examples. Only one of the following may be counted: Electrical and Computer Engineering 396K (Topic 9), Electrical Engineering 396K (Topic 9), Mechanical Engineering 386R (Topic 1). Additional prerequisite: A semester of quantum mechanics and a semester of solid-state science or technology.
Topic 2: Localized-Electron Phenomena. Same as Electrical and Computer Engineering 396K (Topic 17). Analysis of the variation in physical properties versus chemical composition of several groups of isostructural transition-metal compounds. Only one of the following may be counted: Electrical and Computer Engineering 396K (Topic 17), Electrical Engineering 396K (Topic 17), Mechanical Engineering 386R (Topic 2). Additional prerequisite: A semester of solid-state science and/or quantum mechanics.
Topic 3: Transport Properties of Transition-Metal Oxides. Electronic and ionic transport in transition-metal oxides as they relate to battery cathodes, solid oxide cells, spin electronics, thermistors, and high-temperature superconductors.
Topic 4: Nanophotonics and Machine Learning. Explore recent trend of applying artificial intelligence (AI) techniques, especially machine learning, to specific tasks which has revolutionized many research subjects in different fields. Examine the fundamentals of the most important concepts from both sides, such as deep neural networks that has been used to design and decode nanophotonic devices, and metasurfaces and photonic circuits that can perform optical computing. Mechanical Engineering 386R (Topic 4) and 397 (Topic: Nanophotonics/Machine Learning) may not both be counted.

M E 386S. Materials Science: Microelectronics and Thin Films.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

Topic 1: Thin Films and Interfaces. Application of thin films and interfaces in microelectronics; basic properties, deposition techniques, microstructures and defects, diffusion characteristics; materials reaction in thin films and at interfaces.
Topic 2: Metallization and Packaging. Technology requirements and trends, impact of device scaling, multilayered interconnect structures, Schottky and ohmic contacts, contact reactions, silicide properties and applications, electromigration, thermal/mechanical properties, reliability. Additional prerequisite: Mechanical Engineering 386S (Topic 1).

M E 386T. Materials Science: The Design of Technical Materials.

The process of designing a material for a specific engineering function as illustrated for various materials. Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

Topic 1: Ionic Conductors. Same as Electrical and Computer Engineering 396K (Topic 10). Only one of the following may be counted: Mechanical Engineering 386T (Topic 1), Electrical Engineering 396K (Topic 10), Electrical and Computer Engineering 396K (Topic 10).
Topic 2: High-Temperature Superconductors. Same as Electrical and Computer Engineering 396K (Topic 11). Only one of the following may be counted: Mechanical Engineering 386T (Topic 2), Electrical Engineering 396K (Topic 11), Electrical and Computer Engineering 396K (Topic 11).
Topic 3: Catalytic Electrodes. Same as Electrical and Computer Engineering 396K (Topic 12). Only one of the following may be

counted: Mechanical Engineering 386T (Topic 3), Electrical and Computer Engineering 396K (Topic 12), Electrical Engineering 396K (Topic 12).
Topic 4: Magnetic Materials. Same as Electrical and Computer Engineering 396K (Topic 13). Only one of the following may be counted: Electrical and Computer Engineering 396K (Topic 13), Electrical Engineering 396K (Topic 13), Mechanical Engineering 386T (Topic 4).
Topic 5: Battery Systems Engineering. Explore the development of models and algorithms to analyze, optimize, and improve the performance of batteries. Discuss the mathematical formulation for predicting the performance of batteries using physics-based models. Examine a self-contained, fundamental approach to modeling, analysis, operation, and control of batteries. Mechanical Engineering 386T (Topic 5) and 397 (Topic: Battery Systems Engineering) may not both be counted.

M E 387M. Applied Dynamics and Feedback Control.

Restricted to Option III Mechanical Engineering Master's degree students. Provides advanced tools for describing and controlling the motion of dynamical systems. Studies how to apply Newton's Second Law as well as Lagrange's equations to find equations of motion. Emphasis on rigid body dynamics as well as motion constraints arising in complex systems. Examines fundamental concepts in both the time and frequency domains to develop feedback controllers and thus advance from open loop simulation of dynamic systems to closed loop control. Introduces common control strategies and tools for designing and testing control systems. Uses MATLAB extensively throughout the course, and emphasizes applications to realistic systems, simulations and numerical solutions. Three lecture hours a week for one semester. Prerequisite: Graduate standing and admission to the Executive ME program.

M E 387Q. Materials Science: Thermodynamics and Kinetics.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

Topic 1: Diffusion in Solids. Atomic mechanisms and phenomenological basis for transport by diffusion.
Topic 2: Kinetics and Phase Transformations. Nucleation and growth, spinodal decomposition, transformations in alloy systems.
Topic 3: Solidification. Liquid to solid transformations in pure materials, alloys and eutectics; applications such as zone refining, composites, and castings.
Topic 4: Corrosion. Electrode kinetics and the theory of polarization, passivity, galvanic coupling, and high temperature oxidation.
Topic 5: Thermodynamics of Materials. First and second laws, fugacity, activity, chemical equilibrium, phase diagrams, and introductory statistical concepts.
Topic 6: Statistical Thermodynamics of Materials. Quantum mechanics applied to partition functions of condensed and gaseous phases; chemical equilibria; phase transitions; and lattice statistics including the Ising model.
Topic 7: Group Theory and Phase Transformations. Symmetry principles and the associated mathematics applied to the description of condensed phases and their transformations.

M E 387R. Materials Science: Experimental Techniques.

Three lecture hours a week for one semester. Some topics may require additional laboratory hours; these are identified in the Course Schedule. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

Topic 1: Nondestructive Testing. Acoustic emission, ultrasonic, eddy current, dye penetrant, and magnetic methods.
Topic 3: Electron Diffraction and Microscopy. Transmission electron microscopy, kinematic electron diffraction theory, reciprocal lattice, defect analyses, scanning electron microscopy.
Topic 4: Advanced Electron Microscopy Theory and Techniques. Scanning transmission electron microscopy, microanalysis techniques, dynamical diffraction theory, convergent beam diffraction.

Topic 5: Materials Characterization Techniques. Classification and selection of characterization techniques: principles and applications of diffraction, spectroscopic, quantitative chemical analysis, thermal analysis, and transport and magnetic measurement techniques.
Topic 6: High-Resolution Transmission Electron Microscopy Techniques. Theory and practice of high-resolution phase contrast electron microscopy. Computer simulation of images and diffraction patterns.
Topic 7: Scanning Electron Microscopy. Theory and practice of scanning electron microscopy; image formation, elemental analysis, sample preparation, and electron-sample interactions. Three lecture hours and two laboratory hours a week for one semester.
Topic 8: Practical Electron Microscopy. Principles, operation, and techniques of transmission electron microscopy; acquiring and interpreting imaging, diffraction, and spectroscopy information; and hands-on experience with a transmission electron microscope. Three lecture hours and three laboratory hours a week for one semester.
Topic 9: Advanced Methods for Surface Analysis. Restricted to materials science and engineering or mechanical engineering students. Examine the principles and operation of X-ray photoelectron spectroscopy (XPS) and atomic force microscopy (AFM). Explore state-of-the-art methods for acquiring, processing and interpreting the analytical results. Perform hands-on experiments on XPS and AFM followed by data evaluation and interpretation. Mechanical Engineering 387R (Topic 9) and 397 (Topic: Adv Mthds for Srfce Anlysis) may not both be counted.

M E 387S. Materials Processing.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

Topic 2: Processing of Materials. Principles, advantages, and problems of solid, liquid, and vapor materials processes; considerations of structural alloys, ceramics, engineering polymers, and composites.
Topic 3: Powder Processing. Synthesis of powders, powder characterization, powder stabilization, consolidation of powders, sintering, densification, and grain growth.

M E 388C. Nuclear Power Engineering.

Fundamental principles of the design and analysis of nuclear systems; introduction to the physics of nuclear reactions, chain reactions, and nuclear energy generation; heat generation and conduction within nuclear systems; heat transfer and fluid flow in nuclear systems; the thermodynamics of nuclear power; the nuclear fuel cycle; and issues related to the materials aspect of reactor engineering. Three lecture hours a week for one semester. Prerequisite: Graduate standing.

M E 388D. Nuclear Reactor Theory I.

Principle concepts in the physics of nuclear systems, including radiation, radioactive decay, and the buildup and depletion of isotopes in nuclear systems; neutron-nucleus interactions and nuclear cross sections; transport or radiation using one-group and two-group diffusion theory; and concepts of criticality and time dependent reactors. Three lecture hours a week for one semester. Prerequisite: Graduate standing, and Mechanical Engineering 361E or the equivalent.

M E 388E. Nuclear Reactor Theory II.

Neutron-nucleus interactions and nuclear cross section calculations; transport of radiation using neutron transport theory and multigroup diffusion theory; heterogeneous reactor calculations; the kinetics of nuclear systems; perturbation theory; and the nuclear fuel cycle. Three lecture hours a week for one semester. Prerequisite: Graduate standing, and Mechanical Engineering 361E or the equivalent.

M E 388F. Computational Methods in Radiation Transport.

Transport equation, Monte Carlo method, energy and time discretization, discrete ordinates, integral methods, and even-parity methods. Three lecture hours a week for one semester. Prerequisite: Graduate standing.

M E 388G. Nuclear Radiation Shielding.

Radiation fields/sources; techniques in neutron and photon attenuation; transport description of radiation penetration. Three lecture hours a week for one semester. Prerequisite: Graduate standing.

M E 388H. Nuclear Safety and Security.

Examine probabilistic risk assessment models and nuclear arms nonproliferation, including failure classifications; failure mode, effects, and criticality analysis (FMECA); fault and event trees; and reliability block diagrams. Discuss specific areas from the Code of Federal Regulations. Three lecture hours a week for one semester. Mechanical Engineering 388H and Operations Research and Industrial Engineering 390R (Topic 15) may not both be counted.

M E 388J. Neutron Interactions and Their Applications in Nuclear Science and Engineering.

The fundamental principles of neutron interactions with matter and how these interactions are used in a variety of science and engineering research areas. Includes the history of neutron research, fundamental principles, dosimetry, depth profile, radiography, activation analysis, detection, homeland security, and scattering, with a significant emphasis placed on experimental design of these neutron techniques. Three lecture hours a week for one semester. Mechanical Engineering 388J and 397 (Topic: Neutron Interactions and Their Applications in Nuclear Science and Engineering) may not both be counted. Prerequisite: Graduate standing.

M E 388M. Mathematical Methods for Nuclear and Radiation Engineering.

Fundamental mathematics used in graduate studies in nuclear and radiation engineering. Topics include statistics, experimental data, propagation of error, detection limits, and differential and partial differential equations. Three lecture hours a week for one semester. Prerequisite: Graduate standing.

M E 388N. Design of Nuclear Systems.

Integration of fluid mechanics, heat transfer, thermomechanics, and thermodynamics with reactor theory for core design. Three lecture hours a week for one semester. Prerequisite: Graduate standing, and Mechanical Engineering 361E or the equivalent.

M E 388P. Applied Nuclear Physics.

Properties of the nucleus and its structure; binding energy and nuclear stability, and the liquid drop model of the nucleus; the shell model of the nucleus; deuteron bound-state wave function and energy, n-p scattering cross section, transition probability per unit time, and barrier transmission probability; nuclear conservation laws; the energetics and general cross section behavior in nuclear reactions; interactions of charged particles, neutrons, and gamma rays with matter; and alpha, beta, and gamma decay. Three lecture hours a week for one semester. Prerequisite: Graduate standing.

M E 388S. Modern Trends in Nuclear and Radiation Engineering.

Facilitates presentations on research topics in nuclear and radiation engineering outside any research with techniques in proposal writing; or specialized laboratory courses. Three lecture hours a week for one semester. Mechanical Engineering 388S and 397 (Topic: Modern Trends in Nuclear and Radiation Engineering) may not both be counted. Prerequisite: Graduate standing.

M E 389C. Nuclear Environmental Protection.

Ionizing radiation and its interactions with matter and living tissues; radioactive decay kinetics; external and internal dose measurement; transportation through the environment; managing radioactive waste streams; and safeguards. Three lecture hours a week for one semester. Mechanical Engineering 337F and 389C may not both be counted. Prerequisite: Graduate standing.

M E 389F. The Nuclear Fuel Cycle.

A survey of the nuclear fuel cycle, including resource acquisition, fuel enrichment and fabrication, spent fuel reprocessing and repository disposal. Nuclear fuel management and reactor physics are addressed in the context of fuel burn-up calculations. Uses cross-disciplinary tools such as cost-benefit and environmental impact analyses. Includes fuel cycles currently in use, advanced fuel cycle concepts currently being presented in the technical literature, and a group project designed to research, analyze, and document the technical, economic, and/or environmental ramifications of one of these advanced fuel cycles. Three lecture hours a week for one semester. Mechanical Engineering 389F and 397 (Topic: The Nuclear Fuel Cycle) may not both be counted. Prerequisite: Graduate standing.

M E 389M. Materials Processing.

Restricted to Option III Mechanical Engineering Master's degree students. Explores the principles, advantages, and problems of solid, liquid, and vapor materials processes. Studies the considerations of structural alloys, ceramics, engineering polymers, and composites. Three lecture hours a week for one semester. Prerequisite: Graduate standing and admission to the Executive ME program.

M E 389Q. Nuclear and Radiation Engineering: Design of Systems.

Synthesis of engineering concepts, materials specifications, and economics in the design of nuclear systems. Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing, and Mechanical Engineering 361E or the equivalent.

M E 390. Vehicle System Dynamics and Controls.

Fundamentals of ground vehicle dynamics, tire-road mechanics, vehicle control systems, vehicle stability, and simulation of vehicle systems. Three lecture hours a week for one semester. Only one of the following may be counted: Mechanical Engineering 360, 379M (Topic: Vehicle System Dynamics and Controls), 390, 397 (Topic: Vehicle System Dynamics and Controls). Prerequisite: Graduate standing.

M E 390C. Cyber Vehicle Systems.

Study of the engineering principles of autonomous mobile robots. Subjects include understanding the dynamics of vehicle systems, and the principles and practical implementation of sensing, actuation, and control. Emphasis will be given to providing practical laboratory study of these subjects using mobile robot platforms, and the use of the commercial software package LabVIEW for programming of real-time data acquisition and control targets. Simulation studies may also be conducted in LabVIEW and/or the Matlab environment; some proficiency in use of both of these software packages is expected. Three lecture hours a week for one semester. Only one of the following may be counted: Mechanical Engineering 360, 379M (Topic: Cyber Vehicle Systems), 390C, 397 (Topic: Cyber Vehicle Systems). Prerequisite: Graduate standing.

M E 390E. Nuclear Security System Design.

Explore the science and engineering associated with the design, evaluation, and implementation of systems to secure nuclear and radiological materials. Examine methods for planning and evaluating nuclear security activities at the state and facility level. Study the characterization of the adversary, categorization of targets and the consequences associated with failure to protect those targets, detection and delay technologies, on-site and off-site response as well as different response strategies, evaluation of insider threats, mathematical methods for evaluating risk due to the threat and the security system design, and methods for risk minimization and system optimization will also be studied. Three lecture hours a week for one semester. Mechanical Engineering 390E and 397 (Topic: Nuclear Security Sys Design) may not both be counted. Prerequisite: Graduate standing.

M E 390F. Nuclear Analysis Techniques.

Thermal and fast neutron activation, scintillation and solid-state detectors, beta and gamma spectrometry, coincidence techniques. Two lecture hours and one and one-half laboratory hours a week for one semester. Prerequisite: Graduate standing.

M E 390G. Nuclear Engineering Laboratory.

Experiments using the TRIGA reactor and a subcritical assembly; measurement of reactor characteristics and operational parameters. Two lecture hours and one and one-half laboratory hours a week for one semester. Prerequisite: Graduate standing.

M E 390M. The Enterprise of Technology.

Restricted to Option III Mechanical Engineering Master's degree students. Uses early stage technologies to create new and original commercialization plans which include the best first market, establishing technology features in that market, and estimated benefits and costs to deliver a future product to a customer. Includes in-person market research, a written semester journal, and engagement with multiple projects. Reviews later stages of technology entrepreneurship; includes forming a new company, building a business plan, building a team, getting funding, and scale up to manufacturing. Emphasis on gaining proficient knowledge on intellectual property protection and strategy, and the steps and processes necessary to the successful design and manufacture of a product or service. Three lecture hours a week for one semester. Prerequisite: Graduate standing and admission to the Executive ME program.

M E 390N. Health Physics Laboratory.

The application of radiation and radiation protection instrumentation. Includes personnel monitoring; radiation detection systems; gamma-ray spectroscopy; determination of environmental radiation; counting statistics; and gamma and neutron shielding. One lecture hour and three laboratory hours a week for one semester. Prerequisite: Graduate standing.

M E 390T. Nuclear and Radiochemistry.

Theory and application of nuclear and radiochemistry, including alpha, beta, and gamma ray processes; fission products; statistics; solvent extraction; absorption and teaching techniques; various counting methods; and radiation protection. One lecture hour and three laboratory hours a week for one semester. Prerequisite: Graduate standing.

M E 390V. Advanced Nuclear Engineering.

Study radioactivity, fission reactors, nuclear power systems, nuclear power safety, and nuclear interactions: fission and fusion. Three lecture hours a week for one semester Mechanical Engineering 390V and 397 (Topic: Advanced Nuclear Engineering) may not both be counted. Prerequisite: Graduate standing.

M E 390W. Proposal Writing.

Learn to write a full proposal on current research in any science or engineering discipline. Three lecture hours a week for one semester. Mechanical Engineering 390W and 397 (Topic: Proposal Writing) may not both be counted. Prerequisite: Graduate standing.

M E 391M. Introduction to Manufacturing Systems.

Restricted to Option III Mechanical Engineering Master's degree students. With an emphasis on continuous flow manufacturing, provides the knowledge and skill set to analyze and design production systems to decrease manufacturing costs, decrease defects, and shorten delivery time by reducing process cycle times. Three lecture hours a week for one semester. Prerequisite: Graduate standing and admission to the Executive ME program.

M E 391R. Artificial Intelligence Programming for Engineers.

Provides a working knowledge of LISP and compares it with PROLOG; use of the Texas Instruments Explorer, and artificial intelligence techniques applied to engineering problems. Three lecture hours a week for one semester. Prerequisite: Graduate standing and consent of instructor.

M E 392C. Design Optimization and Automation.

Optimization in mechanical design, including monotonicity analysis, gradient-based constrained optimization, tree-searching, and stochastic approaches. Three lecture hours a week for one semester. Prerequisite: Graduate standing and proficiency in C or MATLAB.

M E 392G. Computer Graphics and Computer-Aided Design.

Studies in computer graphics and its application to design. Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing.

Topic 1: Introduction to Computer Graphics. Two- and three-dimensional transformations, projections, and the graphics pipeline; fundamental algorithms for wire frame and hidden surface image generation; interactive techniques, geometric modeling, and realistic rendering using a standard graphics library. Additional prerequisite: Proficiency in C or C++.
Topic 2: Computer-Aided Geometric Design. Introduction to techniques for representing geometry for computer-aided engineering design. Two- and three-dimensional curve formulations, techniques from algebraic and vector geometry, implicit versus parametric definitions; and free-form surface formulation and solid modeling. Additional prerequisite: Proficiency in C or C++.
Topic 3: Advanced Computer-Aided Design Applications. Hardware and software for computer-aided design systems. Display devices, multidimensional graphics, optimization, use of artificial intelligence.
Topic 4: Advanced Topics in Computer-Aided Design. Detailed execution of an independent computer-aided design project. Projects require significant development and emphasize application of techniques from computer-aided engineering and interactive computer graphics. Lectures deal with the subject matter of the projects. Additional prerequisite: Mechanical Engineering 352K, 392G (Topic 1), or 392G (Topic 2); and consent of instructor.

M E 392M. Advanced Mechanical Design.

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

Topic 1: Analytical Techniques in Mechanical Design. Analytical techniques and some computational techniques for the advanced stress and strength analysis of machine components and mechanical structures.
Topic 3: Advanced Design of Machine Elements. Review of basic machine elements, properties, and stresses; fluid couplings and torque converters; thermal stresses, relaxation, and beneficial residual stressing; shells and rotors; plasticity.
Topic 6: Engineering Design Theory and Mathematical Techniques. Design history and philosophy. Survey of current research areas in design theory, methodology, and manufacturing. Tools for solving engineering system design and synthesis problems. Reverse engineering design project.
Topic 7: Product Design, Development, and Prototyping. Methodology and tools for the product development process. Functional designs based on real product needs. Product design project.
Topic 8: Medical Device Design and Manufacturing. Explore how to solve medical device design problems using systematic design thinking and practices. Interpret clinical needs, define an open engineering medical device design problem, including formulating engineering requirements/specifications to address a marketable need. Generate concepts in a way that promotes both creativity and usefulness, make well-informed, well-justified design decisions in the early and later stages of design. Design and analyze experiments, follow statistical best practices in Design of Experiments(DoE), embody solutions with "Design for X" considerations, and communicate intermediate and final designs clearly and effectively in written and oral formats. Mechanical Engineering 392M (Topic 8) and 397 (Topic: Medical Device Design and Manu) may not both be counted.
Topic 9: Precision Machine Design. Discuss modeling, design, integration and best practices for use of machine elements such as bearings, springs, gears, cams and mechanisms. Model and analyze these elements based upon extensive application of physics, mathematics, and core mechanical engineering principles (solid mechanics, fluid mechanics, manufacturing, estimation, computer simulation, etc.). Mechanical Engineering 392M (Topic 9) and 397 (Topic: Precision Machine Design) may not both be counted.
Topic 10: Computational Methods for Engineering Design. Examine several categories of computational methods that are useful for engineering design applications. Implement the methods on example engineering design problems. Mechanical Engineering 392M (Topic 10) and 397 (Topic: Comp Meth for Engr Design) may not both be counted.

M E 392Q. Manufacturing.

Topics that cut across departmental concentrations (mechanical systems and design, metallurgy and materials engineering, operations research and industrial engineering), including design for manufacturing, manufacturing machines and manufacturing processing, and production systems. Three lecture hours a week for one semester; additional laboratory hours may be required for some topics. May be repeated for credit when the topics vary. Prerequisite: Graduate standing.

Topic 1: Introduction to Manufacturing Systems. Analysis and design of production systems to decrease manufacturing costs, decrease defects, and shorten delivery time by reducing process cycle times. Emphasis is on continuous flow manufacturing. Additional prerequisite: A basic understanding of statistics.
Topic 2: Computer Fundamentals for Manufacturing Systems. Computer graphics, computer-aided design, direct numerical control, relationship between computer-aided design and manufacturing.
Topic 4: Automation and Integration of Manufacturing Systems. Integration of automated manufacturing components into a cohesive manufacturing system. Selection of automation strategy, communication and interaction between system components, economics and reliability of the resulting systems.
Topic 5: Manufacturing Processing: Unit Processes. Important unit processing operations in manufacturing: cutting, drilling, and grinding metals, ceramics, composites, and polymers. Deformation processes: forming and rolling. Laser machining.
Topic 6: Mechatronics I. Integrated use of mechanical, electrical, and computer systems for information processing and control of machines and devices. System modeling, electromechanics, sensors and actuators, basic electronics design, signal processing and conditioning, noise and its abatement, grounding and shielding, filters, and system interfacing techniques. Three lecture hours and two laboratory hours a week for one semester.
Topic 7: Microcomputer Programming and Interfacing. Microcomputer architecture and programming; microcomputer system analysis; interfacing and digital control.
Topic 9: Mechatronics II. Interfacing microcomputers with sensors and actuators; hybrid (analog/digital) design; digital logic and analog circuitry; data acquisition and control; microcomputer architecture, assembly language programming; signal conditioning, filters, analog-to-digital and digital-to-analog conversion. Three lecture hours and two laboratory hours a week for one semester.
Topic 10: Statistical Methods in Manufacturing. Same as Operations Research and Industrial Engineering 390Q (Topic 7: Statistical Methods in Manufacturing). Statistical monitoring of manufacturing processes; methods and applications of various control charts; formal design of experiments (DOE), including the statistical evaluation of main and interaction effects, as well as intelligent experimentation through reduced factorial experimental design; Taguchi's design philosophy as applied to response surface methods and gradient-based search techniques; and advanced issues in quality control and design of manufacturing systems. Additional prerequisite: Knowledge of basic probability and statistics and consent of instructor.
Topic 11: High Throughput Nanopatterning. Introduction to the basic tools and materials involved in the patterning processes needed to create nano-scale structures and functional materials and discusses the relevance of these processes to applications in the electronics, display, and energy industries. Examine industry and research roadmaps that provide relevant metrics and timelines for fabrication, materials, nano-enabled components and devices. Explore novel nano-enabled components and devices using relevant computational modeling and simulation tools. Mechanical Engineering 392Q (Topic 11) and 397 (Topic: High Throughput Nanopatterning) may not both be counted.
Topic 12: Additive Manufacturing. Explore, compare, and contrast the major categories of additive manufacturing processes and examine their impact on the design of engineered parts. Mechanical Engineering 392Q (Topic 12) and Mechanical Engineering 397 (Topic: Additive Manufacturing) may not both be counted.
Topic 13: Analytics and Control in Semiconductor Manufacturing. Same as Operations Research and Industrial Engineering 390Q (Topic 9). Learn key data analytics and process control methods for turning metrology and sensing data into useful information and decisions in semiconductor manufacturing. Explore applications of statistical models for statistical process control, as well as applications of dynamic models for virtual metrology and run-to-run control in semiconductor manufacturing systems. Only one of the following may be counted: Mechanical Engineering 397 (Topic: Analytics/Control Semi Manuf), 392Q (Topic 13), Operations Research and Industrial

Engineering 397 (Topic: Analytics/Control Semi Manuf), 390Q (Topic 9).

Topic 14: Bioinspired Micro and Nanostructures. Explore the unique properties, operating principles, and applications of micro/nanostructures that are found in nature. Examine naturally occurring organisms that have unique microscopic features, giving rise to novel behavior not observed in traditional bulk materials. Discuss the design and manufacturing of these bioinspired micro/nanostructures for engineered materials, highlighting applications in renewable energy, aerospace, and next-generation electronics and display. Mechanical Engineering 392Q (Topic 14) and 397 (Topic: Bioinspired Micro/Nanostructures) may not both be counted.

Topic 15: Optical Engineering. Explore optics, with a focus on engineering applications. Review geometrical optics: ray-tracing, reflection, refraction, lens design, imaging optical systems, as well as subjects in wave optics: basic electrodynamics, scalar wave theory, interference, Fresnel and Fraunhofer diffraction, image formation, Fourier optics, and 4F systems. Examine optical systems and metrology instruments, such as the human eye, microscopes/telescopes, and interferometers. Discuss the role of optics in advanced nano/microscale manufacturing, as well as applications in more efficient solar energy systems, engineered materials, and nanotechnology. Mechanical Engineering 392Q (Topic 15) and 397 (Topic: Optical Engineering) may not both be counted.

M E 393M. Engineering Design Innovation.

Restricted to Option III Mechanical Engineering Master's degree students. Focuses on design methodology that includes a survey of current research in areas in design theory and methodology. Studies the tools used for solving engineering system designs and synthesis problems for application in a reverse engineering and redesign project. Three lecture hours a week for one semester. Prerequisite: Graduate standing and admission to the Executive ME program.

M E 394M. Topics in Mechanical Engineering.

Restricted to Option III Mechanical Engineering Master's degree students. Topics in Engineering. Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and admission to the Executive ME program.

M E 395. The Enterprise of Technology.

Studies the basis for assessing emerging technologies. Describes the process of technology commercialization, including identifying marketable technologies, defining products, and matching products to markets. Also studies intellectual property protection and strategy, and the steps and processes necessary to the successful design and manufacture of a product or service. Three lecture hours a week for one semester. Mechanical Engineering 395 and 397 (Topic: Enterprise of Technology: Laboratory to Market) may not both be counted. Prerequisite: Graduate standing.

M E 395M. Engineering Design and Innovation with Product Design.

Restricted to students in the Executive ME program. Focuses on design methodology that includes a survey of current research in areas in design theory and methodology. Designed to help students acquire tools for solving engineering system designs and synthesis problems which they can apply in a reverse engineering and redesign project. Three lecture hours a week for one semester. Prerequisite: Graduate standing.

M E 396D. Decision and Control of Human-Centered Robots.

Geared toward students who would like to use Python for their engineering careers with a focus on sharing and development of open source software applications. Emphasis on the important areas of system modeling, simulation, data analysis, and software/data management. Students create mini-projects in Python where they apply basic knowledge on software design and organization, debugging, open source practices, and data visualization. It is expected that students have some experience in programming and would like to advance to the next level. Three lecture hours a week for one semester. Aerospace Engineering 381P (Topic 13) and Mechanical Engineering 396D may not both be counted. Prerequisite: Graduate standing and consent of the graduate adviser.

M E 396M. Materials Science and Engineering.

Restricted to students in the Executive ME program. An exploration of the fundamental aspects of the relationships between processing, structure, properties and performance of engineering materials. Exploration of metals, ceramics, polymers, and composites. Three lecture hours a week for one semester. Prerequisite: Graduate standing.

M E 396P. Application Programming for Engineers.

Designed for students who have some experience in programming and are interested in the sharing and development of open source software applications. Provides an introduction to the Python programming language, an open source, flexible, and intuitive debug programming language, with an emphasis on system modeling, simulation, data analysis, and software/data management. Students create mini projects in Python that demonstrate software design and organization, debugging, open source practices, and data visualization. Three lecture hours a week for one semester. Prerequisite: Graduate standing and consent of the graduate adviser.

M E 397. Current Studies in Engineering.

The equivalent of three class hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of the graduate adviser.

Topic 8: Energy and the Environment. Additional prerequisite: Consent of instructor.

M E 197K, 297K, 397K. Graduate Seminar.

For each semester hour of credit earned, one lecture hour a week for one semester. May be repeated for credit when the topics vary. Offered on the credit/no credit basis only. Prerequisite: Graduate standing.

Topic 1: Acoustics Seminar. Offered on the credit/no credit basis only.
Topic 2: Advanced Thermal/Fluid Seminar. Offered on the credit/no credit basis only.
Topic 3: Materials Engineering. Offered on the credit/no credit basis only.
Topic 4: Mechanical Systems and Design. Offered on the credit/no credit basis only.
Topic 5: Nuclear Engineering. Offered on the credit/no credit basis only.
Topic 6: Introductory Thermal/Fluid Seminar. Offered on the credit/no credit basis only.

M E 397M. Graduate Research Internship.

Research associated with enrollment in the Graduate Research Internship Program (GRIP). Three lecture hours a week for one semester. Offered on the credit/no credit basis only. Prerequisite: Graduate standing and consent of instructor and the dean of the Cockrell School of Engineering.

M E 197P, 297P, 397P. Projects in Mechanical Engineering.

Independent project carried out under the supervision of a mechanical engineering faculty member. Three, six, or nine laboratory hours a week for one semester. Prerequisite: Graduate standing and consent of instructor and the graduate adviser.

M E 698. Thesis.

The equivalent of three lecture hours a week for two semesters. Offered on the credit/no credit basis only. Prerequisite: For 698A, graduate standing in mechanical engineering and consent of the graduate adviser; for 698B, Mechanical Engineering 698A.

M E 398M. Introduction to Automatic Control.

Restricted to students in the Executive ME program. Gain a basic intuition for and understanding of linear feedback systems and develop the mathematical tools to understand the basics of design and analysis of single-input single-output feedback control systems. Builds on the system modeling skills developed in previous courses in order to better understand how to control a system's behavior. Three lecture hours a week for one semester. Prerequisite: Graduate standing.

M E 198P, 398P, 698P. Engineering Teaching Practicum.

Mentored teaching experience completed by arrangement with the instructor of record for an undergraduate engineering course. May be completed in the same semester as a Teaching Assistant or Assistant Instructor assignment with additional responsibilities. For each semester hour of credit earned, the equivalent of one lecture hour a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Mechanical Engineering 397 (Topic: Curriculum Design in Engineering) and 397 (Topic: Teaching Engineering) or equivalent; and admission to the Graduate Certificate in Engineering Education Program; and consent of the graduate adviser.

M E 198Q, 398Q. Teaching Portfolio Preparation.

Project course for students completing the Graduate Certificate in Engineering Education Program to prepare a portfolio highlighting their teaching qualifications and experiences. Not recommended for students with limited teaching experience or students who are within a few years of applying for full-time employment. For each semester hour of credit earned, one lecture hour a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Consent of the graduate adviser.

M E 398R. Master's Report.

Preparation of a report to fulfill the requirement for the master's degree under the report option. The equivalent of three lecture hours a week for one semester. Offered on the credit/no credit basis only. Prerequisite: Graduate standing in mechanical engineering and consent of the graduate adviser.

M E 398S. Assessment and Curriculum Design in Engineering.

Develop curriculum design skills in preparation for engineering faculty positions, including writing learning outcomes, assessing student learning and aligning expectations to activities and outcomes. Assessment is framed as an integrated part of course design, considers the strengths and weaknesses of a variety of quantitative and qualitative assessment strategies. Practice engineering course design and learn important considerations in coordinating department or college resources in preparation for an ABET engineering accreditation review. Three lecture hours a week for one semester. Mechanical Engineering 397 (Topic: Assess & Curric Design in Engr) and 398S may not both be counted. Prerequisite: Graduate standing.

M E 398T. Supervised Teaching in Mechanical Engineering.

Application of learning and motivation theories to learning in engineering contexts. Practice teaching in nontraditional formats. Preparation of a teaching philosophy. Teaching under close supervision, group meetings or individual consultations, and reports as required. Three lecture hours a week for one semester. Prerequisite: Graduate standing and appointment as a teaching assistant.

M E 399W, 699W, 999W. Dissertation.

May be repeated for credit. Offered on the credit/no credit basis only. Prerequisite: Admission to candidacy for the doctoral degree.

Professional Courses