

MECHANICAL ENGINEERING (MCEN)

Courses

MCEN 1024 (3) Chemistry for Energy and Materials Science

Covers the basic physical and chemical fundamentals underlying the disciplines of energy and materials, with a focus on topics relevant to your mechanical engineering education. These fundamentals include atomic structure, stoichiometry, the periodic table, chemical bonding, states of matter, thermochemistry and chemical reactions.

Equivalent - Duplicate Degree Credit Not Granted: CHEN 1201, CHEN 1211, or CHEM 1113

Requisites: Restricted to Mechanical Engineering (MCEN) or Integrated Design Engineering (IDEN-BSIDE) students with a sub-plan of Mechanical (MEC).

Recommended: Prerequisite one year of high school chemistry.

Additional Information: Departmental Category: Materials

MCEN 1025 (4) Computer-Aided Design and Fabrication

Introduces CAD software and relevant concepts, including orthographic projection, sections, engineering drawing, geometric dimensioning and tolerancing, and an introduction to manufacturing methods. Final design project involves rapid prototyping.

Requisites: Restricted to Mechanical Engineering (MCEN) or Engineering Physics (EPEN) majors only.

Additional Information: Departmental Category: Design

MCEN 1208 (1-4) Special Topics in Mechanical Engineering

Subject matter to be selected from topics of current interest. Credit to be arranged.

Requisites: Restricted to students with 0-26 units (Freshmen) Mechanical Engineering (MCEN) majors only.

Additional Information: Departmental Category: Special Topics

MCEN 2000 (1) Mechanical Engineering as a Profession

Provides an introduction to the profession of mechanical engineering. Specific topics addressed include career opportunities in mechanical engineering, internship search skills, expectations for professional behavior in the classroom and in industry, and current events/ethics topics relevant to the field. Course format may include additional evening/weekend activities.

Requisites: Restricted to students with 27-180 credits (Sophomores, Juniors or Seniors) Mechanical Engineering (MCEN) majors only.

Additional Information: Departmental Category: Miscellaneous

MCEN 2023 (3) Statics and Structures

Covers statics of particles, equivalent force systems, rigid bodies, equilibrium of rigid bodies in two and three dimensions, analysis of truss and frame structures, uniaxially-loaded members, distributed force systems and friction.

Equivalent - Duplicate Degree Credit Not Granted: CVEN 2121 or GEEN 2851

Requisites: Requires prerequisite courses of (APPM 1360 or MATH 2300) and PHYS 1110 (all minimum grade C). Restricted to Mechanical (MCEN) or Environmental (EVEN) or Biomedical (BMEN) or Integrated Design Eng (IDEN-BSIDE) students with a sub-plan of Mechanical (MEC)

Additional Information: Departmental Category: Solids

MCEN 2024 (3) Materials Science

Provides an overview of the structure, properties and processing of metallic, polymeric and ceramic materials. Specific topics include perfect and imperfect solids, phase equilibria, transformation kinetics, mechanical behavior and material degradation. Approach incorporates both materials science and materials engineering components.

Equivalent - Duplicate Degree Credit Not Granted: GEEN 3024

Requisites: Requires prerequisite courses of (MCEN 1024 or CHEN 1211 or CHEM 1113 or CHEN 1201) and PHYS 1110 (all minimum grade C).

Restricted to Mechanical (MCEN) or Integrated Design Engineering (IDEN-BSIDE) students with a sub-plan of Mechanical (MEC).

Additional Information: Departmental Category: Materials

MCEN 2043 (3) Dynamics

Covers dynamic behavior of particle systems and rigid bodies; 2-D and 3-D kinematics and kinetics; impulse, momentum, potential, and kinetic energy; and work, collision, and vibration.

Equivalent - Duplicate Degree Credit Not Granted: CVEN 3111

Requisites: Requires prerequisite courses of (MCEN 2023 or CVEN 2121 or GEEN 2851) and (APPM 1360 or MATH 2300) (all minimum grade C).

Restricted to Mechanical (MCEN) or Integrated Design Engineering (IDEN-BSIDE) students with a sub-plan of Mechanical (MEC).

Additional Information: Departmental Category: Solids

MCEN 2063 (3) Mechanics of Solids

Covers shear force and bending moment, torsion, stresses in beams, deflection of beams, matrix analysis of frame structures, analysis of stress and strain in 2-D and 3-D (field equations, transformations), energy methods, stress concentrations and columns.

Equivalent - Duplicate Degree Credit Not Granted: CVEN 3161

Requisites: Requires prerequisite courses of (MCEN 2023 or CVEN 2121 or GEEN 2851 or ASEN 2001) and (APPM 1360 or MATH 2300) (all minimum grade C). Restricted to Mechanical (MCEN) or Biomed (BMEN) or Integrated Design Engr (IDEN-BSIDE) students w/ sub-plan of MEC.

Additional Information: Departmental Category: Solids

MCEN 3012 (3) Thermodynamics

Explores fundamental concepts and basic theory, including first and second laws of thermodynamics, properties, states, thermodynamic functions and cycles.

Equivalent - Duplicate Degree Credit Not Granted: GEEN 3852

Requisites: Requires prereq course of APPM 2350 or MATH 2400 (minimum grade C). Restricted to Mechanical (MCEN) or Environmental (EVEN) or Integrated Design Engineering (IDEN-BSIDE) students, with a sub-plan of Mechanical (MEC).

Additional Information: Departmental Category: Thermal

MCEN 3017 (3) Circuits and Electronics

Introductory course covers analysis of electric circuits by use of Ohm's law, network reduction, node and loop analysis, Thevenin's and Norton's theorems, DC and AC signals, transient response of simple circuits, transfer functions, basic diode and transistor circuits and operational amplifiers.

Equivalent - Duplicate Degree Credit Not Granted: ECEN 3010

Requisites: Requires prerequisite courses of APPM 2360 and PHYS 1140 (all minimum grade C).

Additional Information: Departmental Category: Miscellaneous

MCEN 3021 (3) Fluid Mechanics

Examines fundamentals of fluid flow with application to engineering problems. Topics covered include fluid statics and kinematics, Bernoulli equations, laminar and turbulent viscous boundary layers, laminar and turbulent pipe flow, and conservation equations for mass, momentum and energy.

Equivalent - Duplicate Degree Credit Not Granted: CHEN 3200 and CVEN 3313

Requisites: Requires prereqs (MCEN 2023 or CVEN 2121 or GEEN 2851 or ASEN 2001 or CHEN 2120) (APPM 2350 or MATH 2400) (all min grade C). Restricted to Mechanical (MCEN) or Environmental (EVEN) or Integrated Design Eng (IDEN-BSIDE) students w/ sub-plan of MEC.

Additional Information: Departmental Category: Fluids

MCEN 3022 (3) Heat Transfer

Studies fundamentals of heat transfer by conduction, convection, and radiation. Emphasizes problem formulation and selection of appropriate solution techniques. Provides applications to modern engineering systems, which may include energy, biological, environmental, and materials engineering problems.

Requisites: Requires prereq (MCEN 3021 or CVEN 3313), (MCEN 3012 or AREN 2110 or GEEN 3852 or EVEN 3012), (APPM 2360 or MATH 3130 or 3135 or APPM 3310) (min grade C). Restricted to Mech Engineering or Enviro Engineering or Integrated Design Engr w/sub-plan of MEC

Additional Information: Departmental Category: Thermal

MCEN 3025 (3) Component Design

Application of mechanics and materials science to the detailed design of various machine elements including shafts, bearings, gears, brakes, springs, and fasteners. Emphasizes application and open-ended design problems.

Requisites: Requires prerequisite courses of MCEN 1025 and (MCEN 2024 or GEEN 3024 or ASEN 1022), and (MCEN 2063 or CVEN 3161) (all minimum grade C). Restricted to Mechanical (MCEN) or Integrated Design Eng (IDEN-BSIDE) students with a sub-plan of Mechanical (MEC).

Additional Information: Departmental Category: Design

MCEN 3030 (3) Computational Methods

Studies fundamental numerical techniques for the solution of commonly encountered engineering problems. Includes methods for linear and nonlinear algebraic equations, data analysis, numerical differentiation and integration, ordinary and partial differential equations.

Requisites: Requires prerequisite courses of (APPM 2360 or MATH 3130 or MATH 3135 or APPM 3310) and (CSCI 1300 or CSCI 1310 or CSCI 1320 or ECEN 1310 or ASEN 1320) (all min grade C). Restricted to Mechanical Engineering (MCEN) majors only.

Additional Information: Departmental Category: Math

MCEN 3032 (3) Thermodynamics 2

Offers advanced topics and applications for thermal system design and analysis. Topics include thermodynamics of state, entropy, thermodynamic cycles and reacting and nonreacting mixtures. Provides application to power generation, refrigeration and HVAC with conventional and advanced technologies. Most assignments are design oriented.

Requisites: Requires prereq of (MCEN 3021 or CHEN 3200 or CVEN 3313) (MCEN 3012 or GEEN 3852 or AREN 2110 or EVEN 3012 or CHEN 2120) (APPM 2360 or MATH 3130 or 3135 or APPM 3310) (all min grade C).

Restricted to Mech Engineering or Enviro Engineering majors.

Additional Information: Departmental Category: Thermal

MCEN 3047 (4) Data Analysis and Experimental Methods

Learn to plan and carry out experiments and analyze the results. Topics covered include measurement fundamentals, design of experiments, elementary statistics and uncertainty analysis. Topics in statistics include probability, error propagation, confidence intervals, hypothesis testing, linear regression, one- and two-factor ANOVA and time series analysis. Formerly MCEN 3037.

Equivalent - Duplicate Degree Credit Not Granted: GEEN 3853

Requisites: Prereqs PHYS 1140,(MCEN 2063 or CVEN 3161)min grade C. Coreqs 1 of:(WRTG 3030,3035,ENES 1010,3100,PHYS 3050,COEN 3050,ENLP 3100), 1 of:(ECEN 3010,2270,GEEN 3010,MCEN 3017), 1 of:(MCEN 3030,APPM 4650,CSCI 3656).Restricted to MCEN or IDEN w/ sub-plan MEC.

Additional Information: Departmental Category: Miscellaneous

MCEN 3208 (1-4) Special Topics in Mechanical Engineering

Subject matter to be selected from topics of current interest.

Repeatable: Repeatable for up to 15.00 total credit hours.

Requisites: Requires prereq courses of APPM 2360 PHYS 1140 and prereq or coreq courses of ECEN 3010 and WRTG 3030 or WRTG 3035 or HUEN 1010 or 3100 (all min grade C). Restricted to students with 57-180 credits (Jrs/Srs) Mechanical Engineering (MCEN) majors only.

Additional Information: Departmental Category: Special Topics

MCEN 3930 (6) Mechanical Engineering Cooperative Education

Students enrolled in this course participate in a previously arranged, department-sponsored education program with a university, government agency, or industry. This course is offered only through Continuing Education.

Repeatable: Repeatable for up to 6.00 total credit hours.

Requisites: At least a 2.75 cumulative GPA is required. Restricted to Mechanical Engineering or students with a plan of Mechanical Engineering Concurrent Degree or Integrated Design Engineering students with a MCEN subplan.

Recommended: Prerequisite 3.00 GPA or higher.

Additional Information: Departmental Category: Math

MCEN 4010 (3) Microsystems Integration

A microsystem consists of microelectronic, optoelectronic, microwave, microelectromechanical and energy components interconnected. Thermal, electrical, fabrication and assembly issues for microsystems represented by iPhone series will be studied. The packaging and interconnection technologies used to establish the design and manufacturing infrastructure of microsystems will be reviewed. Other optoelectronic, MEMS and batter components for microsystems will also be studied.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5010

Requisites: Restricted to students with 87-180 credits (Senior, Fifth Year Senior) Mechanical Engineering (MCEN) majors only.

MCEN 4012 (3) Renewable Fuels, Fuel Cells and Internal Combustion Engines

With the accelerated availability of carbon-free and renewable fuels, we will explore high-efficiency, low-emissions fuel cell and internal combustion engine energy conversion technologies, preparing students to enter the rapidly changing fields of power and propulsion on the path to net-zero greenhouse gas emissions. Through thermodynamic modeling, systems engineering, and requirements flow-down, students will apply the fundamentals of thermodynamics, fluids and heat transfer, combustion and electrochemistry for fuel cells and IC engines.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5012

Requisites: Requires prerequisite course of MCEN 3032 (minimum grade C). Restricted to College of Engineering and Applied Sciences students.

Recommended: Prerequisites MCEN 4152/5152 or MCEN 4194/5194.

MCEN 4026 (3) Manufacturing Processes and Systems

Examines manufacturing processes for metals, polymers, and composites as well as manufacturing systems that integrate these processes. Lecture topics include forming, machining, joining, assembling, process integration, computer-aided manufacturing, and manufacturing system engineering.

Requisites: Requires prerequisite course of MCEN 2024 or GEEN 3024 or ASEN 1022 (minimum grade C). Restricted to Mechanical Engineering (MCEN) majors only.

Additional Information: Departmental Category: Manufacturing and Systems

MCEN 4032 (3) Sustainable Energy

Examines sustainability of our current energy systems, including transportation, using environmental and economic indicators. Uses systems analysis that addresses energy supply and demand. Explores the science and technology as well as environmental and economic feasibility of efficiency measures and renewable energy technologies. Additional emphasis is given to the global nature of the challenges and the potential for locally optimal solutions.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5032

Requisites: Requires prerequisite course of (MCEN 3012 or GEEN 3852 or AREN 2110 or EVEN 3012) and (MCEN 3022 or CHEN 3210) (minimum grade C).

Additional Information: Departmental Category: Thermal

MCEN 4043 (3) System Dynamics

Covers linear dynamic systems and mathematical tools for understanding them, input-output relationships, modeling templates, complex variables, Laplace transform, time-harmonic forcing and response, Fourier series and discrete Fourier transform, and coupled systems.

Requisites: Requires prereqs (MCEN 2043 or CVEN 3111), (ECEN 3010 or 2270 or GEEN 3010 or MCEN 3017), coreq (MCEN 3030 or APPM 4650 or CSCI 3656) all min grade C. Restricted to Mechanical (MCEN) or Integrated Design Engr (IDEN-BSIDE) stdnts w/ sub-plan of MEC.

Additional Information: Departmental Category: Solids

MCEN 4045 (3) Mechanical Engineering Design Project 1

First part of a two-course capstone design experience in mechanical engineering. Covers problem definition, determining design requirements, alternative design concepts, engineering analysis, proof-of-concept prototype and CAD drawings. Students make several oral design reviews, a final design presentation, and prepare a written report. GEEN-BS and GEEN-BSGE students are not required to complete MCEN 2000, MCEN 3022, MCEN 3030 or MCEN 4026 but have additional prerequisites of GEEN 1400, 2400 and 3400.

Requisites: Prereqs ECEN3010/CSCI1320/GEEN1400/ APPM1350/1360/2350/2360/PHYS1110/1120/1140 MCEN2000/2024/2043/2063/3012/3021/3025/3030 min grd C. Pre or coreqs MCEN3022/3047/4026/4043/WRTG3030. Restricted to stdnts w 87-180 units, MCEN or IDEN stdnts w sub-plan ME

Additional Information: Departmental Category: Design

MCEN 4057 (3) Environmental Modeling

Enables students to develop and evaluate pollutant transport, fate, exposure, and risk models for air, water, and multi-media systems, with a special emphasis on air. Emphasizes the fundamental physics and chemistry that govern contaminant fate and transport and the basic mathematical equations and numerical approaches for describing these processes.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5057

Requisites: Requires prerequisite courses of CHEN 1211 or CHEM 1113 or MCEN 1024 and CSCI 1300 or CSCI 1320 (all minimum grade C).

Additional Information: Departmental Category: Miscellaneous

MCEN 4064 (3) Soft Machines

Introduces soft machines as a new paradigm of engineering that starts to impact healthcare, consumer electronics, renewable energy and collaborative robotics. Prepares students to participate in research on soft machines by starting with fundamentals of soft materials and by covering soft robotics, stretchable electronics, energy harvesting and functional polymers. Includes guest lectures, a literature review and a hands-on lab project.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5046 and MSEN 5046

Requisites: Restricted to students with 87-180 credits (Senior, Fifth Year Senior) Mechanical Engineering (MCEN) majors only.

MCEN 4085 (3) Mechanical Engineering Senior Design Project 2

Second part of a two-course capstone design experience in mechanical engineering. Includes refinement of prototype, design optimization, fabrication, testing, and evaluation. Students orally present the final design and prepare a written report and operation manual for the product. GEEN-BS and GEEN-BSEPL students are not required to complete MCEN 4026.

Requisites: Requires prerequisite course of MCEN 4045 (minimum grade C).

Additional Information: Departmental Category: Design

MCEN 4086 (1) Writing for Design Projects

Communicate professionally in writing to the technical and nontechnical audience. Develop skills to analyze rhetorical situations and compose documents, such as reports, technical manuals and user guides, that achieve a specific purpose and meet the needs of a particular audience. Writing with clarity, conciseness and correctness will be emphasized.

Requisites: Requires enrollment in corequisite course of MCEN 4085.

Additional Information: Departmental Category: Manufacturing and Systems

MCEN 4113 (3) Mechanics of Cancer

Cancer is considered to be an organ or an ecosystem, in which a critical component of the tumor microenvironment is mechanical forces. This course will cover the role of mechanics in cancer and cancer-related processes, with a focus on solid mechanics and fluid mechanics. In this course, you will apply engineering principles to come away with an appreciation of how mechanics influence cancer and its etiology as well as the development of future treatments.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5113

Requisites: Requires prerequisite course of MCEN 3021 or CHEN 3200 or CVEN 3313 or MCEN 2063 or CVEN 3161 (all minimum grade C).

Restricted to Mechanical and Biomedical Engineering majors with 57+ credits only.

MCEN 4115 (3-4) Mechatronics and Robotics I

Focuses on design and construction of microprocessor-controlled electro-mechanical systems. Lectures review critical circuit topics, introduce microprocessor architecture and programming, discuss sensor and actuator component selection, robotic systems and design strategies for complex, multi-system devices. Lab work reinforces lectures and allows hands-on experience with robotic design. Students must design and build an autonomous robotic device. Project expenses may be incurred (\$50 maximum).

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5115

Requisites: Requires prerequisite courses of (ECEN 3010 or 2250 or GEEN 3010) and (ECEN 1310 or CSCI 1300 or CSCI 1320 or ASEN 1320) (all min grade C). Restricted to Mechanical Engineering majors only.

Additional Information: Departmental Category: Design

MCEN 4117 (3) Anatomy and Physiology for Engineers

Explores human physiological function from an engineering, specifically mechanical engineering, viewpoint. Provides an introduction to human anatomy and physiology with a focus on learning fundamental concepts and applying engineering (mass transfer, fluid dynamics, mechanics, modeling) analysis.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5117

Requisites: Restricted to Mechanical or Biomedical Engineering majors with 57+ credits only.

Additional Information: Departmental Category: Miscellaneous

MCEN 4123 (3) Vibration Analysis

Highlights free and forced vibration of discrete and continuous systems. Examines Lagrange's equation, Fourier series, Laplace transforms, and matrix and computational methods. Applies knowledge to practical engineering problems.

Equivalent - Duplicate Degree Credit Not Granted: ASEN 4123

Requisites: Requires prerequisite course of (MCEN 3030 or APPM 4650 or CSCI 3656 or ASEN 3112) (minimum grade C). Restricted to Mechanical Engineering majors with 57+ credits only.

Additional Information: Departmental Category: Solids

MCEN 4124 (3) Mechanical Behavior of Materials

Addresses the relationship between material structure and the fundamental processes of deformation, yield, and fracture. Examines elements of elasticity theory, introduction to plasticity, and formulation of failure criteria. Studies basic deformation processes in terms of dislocation mechanics and macroscopic mechanical behavior. Takes into consideration the influence of compositional and processing strengthening mechanisms on mechanical properties.

Requisites: Requires prerequisite courses of (MCEN 2024 or GEEN 3024 or ASEN 1022) and (MCEN 2063 or CVEN 3161) (all minimum grade C). Restricted to Mechanical Engineering majors with 57+ credits only.

Additional Information: Departmental Category: Materials

MCEN 4125 (3) Optimal Design

Focuses on linear optimization and will introduce non-linear optimization. Formulating Engineering applications as optimization problems that can be solved using industry known solvers will be learned. Some of these applications will include minimum cost mechanical design, wind farm power maximization, minimum energy control, production control, and more. Previous programming experience required.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5125

Requisites: Requires prerequisite course of (MCEN 3030 or APPM 4650 or CSCI 3656) (minimum grade C). Restricted to Mechanical Engineering majors with 57+ credits only.

Additional Information: Departmental Category: Design

MCEN 4127 (3) Biomedical Ultrasound

Covers the design of ultrasound systems for medical imaging and therapy, including the physics of wave propagation, transducers, pulse-echo imaging, flow and tissue characterization, and microbubble contrast, with an emphasis on current topics in biomedical ultrasound. Includes lectures on theory, practice and special topics; a laboratory on wave propagation; oral presentations on current literature; programming exercises for data processing; and a team design project.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5127

Requisites: Restricted to Mechanical or Biomedical Engineering majors with 87+ credits only.

Additional Information: Departmental Category: Miscellaneous

MCEN 4131 (3) Air Pollution Control Engineering

Introduces air quality regulations, meteorology and modeling. Examines methods for controlling major classes of air pollutants, including particulate matter and oxides of sulfur and nitrogen, as well as control technology for industrial sources and motor vehicles. Requires interdisciplinary design projects.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5131

Requisites: Requires prerequisite courses of (MCEN 3021 or CHEN 3200 or CVEN 3313) and (MCEN 3012 or GEEN 3852 or AREN 2110 or EVEN 3012) (all minimum grade C). Restricted to Mechanical Engineering or Environmental Engineering majors with 57+ credits only.

Additional Information: Departmental Category: Fluids

MCEN 4133 (3) Intro to Tissue Biomechanics

Focuses on developing an understanding of the fundamental mechanical principles that govern the response of hard and soft biological tissue to mechanical loading. Specifically, covers mechanical behavior of biological materials/tissues, classical biomechanics problems in various tissues, the relationship between molecular, cellular and physiological processes and tissue biomechanics and critical analysis of related journal articles.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5133

Requisites: Requires prerequisite courses of [BMEN 2010 or MCEN 2024] and [BMEN 3010 or (MCEN 2063 and MCEN 3021)] (all minimum grade C). Restricted to students with 87+ credits (Senior, Fifth Year Senior) Mechanical Engineering and Biomedical Engineering majors

Additional Information: Departmental Category: Materials

MCEN 4135 (3) Wind Energy and Wind Turbine Design

Focuses on understanding and applying principles related to current wind energy technologies. Students will apply technical coursework from throughout the engineering curriculum (environmental, fluids, statics, dynamics, power, economics, etc.) to the process of designing wind turbines and wind farms. Practical, real world examples will be integrated into the lessons and problems.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5135

Requisites: Requires prerequisite courses of (MCEN 3021 or CHEN 3200 or CVEN 3313 or AREN 2120) and (ECEN 3010 or GEEN 3010 or ECEN 2270) (all minimum grade C). Restricted to Mechanical or Environmental Engineering majors with 57+ credits only.

Additional Information: Departmental Category: Design

MCEN 4137 (3) Anatomy and Physiology 2

Provides in-depth understandings of anatomy and physiology as well as introductions to transport phenomena, flow mechanics and solid mechanics in several organ systems: the cardiovascular, pulmonary, kidney, endocrine and digestive systems. Introduces artificial physiological systems to replace or assist physiological functions and introduce the concepts of physiological barriers that prevent diagnosis or effective therapeutics.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5137

Requisites: Requires prerequisite course of MCEN 4117 (minimum grade C). Restricted to students with 57-180 credits (juniors/seniors).

Grading Basis: Letter Grade

Additional Information: Departmental Category: Miscellaneous

MCEN 4138 (3) Feedback Control

Introduction to fundamental principles and techniques for analysis and synthesis of feedback control systems in the time and frequency domains. Laplace transforms, transfer functions and block diagrams. Stability, dynamic response, and steady-state analysis. Analysis and design of control systems using root locus and frequency response methods. Computer aided design and analysis. Introduction to state space representations and state feedback control.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5138 ECEN 4138 or ECEN 5138

Requisites: Requires prerequisite of MCEN 4043 or ECEN 3300 (minimum grade C). Restricted to students with 87-180 credits (Senior, Fifth Year Senior) Mechanical Engineering majors only.

MCEN 4141 (3) Indoor Air Pollution

Describes the impact of indoor air pollutants on human health, including an introduction to key pollutants and their sources. Students will estimate emission factors, calculate generation/ventilation rates, quantify the impact of deposition and chemical reactions and explore relevant control technology. Current issues will also be addressed, including climate change, green building design, economic concerns and relevance to the developing world.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5141

Requisites: Requires prerequisite courses of (MCEN 3022 or CHEN 3210) (minimum grade C). Restricted to Mechanical and Environmental Engineering majors with 57+ credits only.

Additional Information: Departmental Category: Fluids

MCEN 4151 (3) Flow Visualization

Explores techniques for the visualization of the physics of fluid flows including seeding with dyes, particles and bubbles, and shadowgraphy and schlieren. Reviews optics and fluid physics, especially atmospheric clouds. Assignments are student-driven, to individuals and mixed teams of graduates, undergraduates, engineering majors and photography/video majors.

Equivalent - Duplicate Degree Credit Not Granted: ARTF 5200, CINE 4200, MCEN 5151, ATLS 4151 and ATLS 5151

Requisites: Requires prerequisite course of (MCEN 3021 or CHEN 3200 or CVEN 3313) (minimum grade C). Restricted to Mechanical Engineering majors with 57+ credits only.

Additional Information: Arts Sci Gen Ed: Distribution-Arts Humanities
Departmental Category: Fluids

MCEN 4152 (3) Introduction to Combustion

Focuses on the mechanisms by which fuel and oxidizers are converted into combustion products. Application to practical combustion devices such as Otto, Diesel, gas turbine and power plant combustion systems. Consideration of combustion-generated air pollution, fire safety and combustion efficiency.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5152

Requisites: Requires prerequisite course of MCEN 3012 (minimum grade C). Restricted to students with 87-180 credits (Senior, Fifth Year Senior) Mechanical Engineering majors only.

Recommended: Prerequisites MCEN 3021 and MCEN 3022.

Additional Information: Departmental Category: Thermal

MCEN 4154 (3) Biocolloids and Biomembranes

Covers the thermodynamics and mechanics of biological membranes and biomedical colloids. Considers intermolecular and surface forces, self-assembly and colloidal stability. Addresses structure-property relationships and design principles for biomedical applications. Focuses on monolayers, bilayers, micelles, filomicelles, liposomes, polymersomes, emulsions, microbubbles, polyplexes and polyelectrolyte multilayer capsules.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5154

Requisites: Requires prerequisite courses of (APPM 2360 or MATH 3130 or MATH 3135 or APPM 3310) and (PHYS 1120 or PHYS 1125) (all minimum grade C). Restricted to Mechanical Engineering students with 57+ credits only

Additional Information: Departmental Category: Materials

MCEN 4155 (3) Automated Mechanical Design Synthesis

Introduces computational approaches to automatically generate complex multimaterial mechanical designs that satisfy predefined high-level specifications, discusses algorithms to solve design as a constrained non-convex multi-objective optimization problem. Topics: expert-driven design process; computational analysis tools based on mechanical simulation (finite element methods, mesh-free methods); topological optimization; compositional design; multi-objective optimization; evolutionary design; design for manufacturing with additives (FDM, SLA, Inkjet). Students design a part to specifications, fabricate using advanced (3D printing, laser cutting, CNC, etc) tools.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5155

Requisites: Requires prerequisite course of MCEN 3030 or APPM 4650 or CSCI 3656 (all minimum grade C). Restricted to Mechanical Engineering majors with 87+ credits only.

Recommended: Prerequisite students should be comfortable with MATLAB, PDEs, linear algebra, free body diagrams, mechanical modeling/design; exposure to finite-element modeling and state-space representations.

MCEN 4157 (3) Modeling of Human Movement

Human movement analysis is used in physical rehabilitation, sport training, human-robot interaction, animation, and more. Course provides a systematic overview of human movement on multiple levels of analysis, with an emphasis on the phenomenology amenable to computational modeling. Covers muscle physiology, movement-related brain areas, musculoskeletal mechanics, forward and inverse dynamics, optimal control and Bayesian inference, learning and adaptation. Inspires students to see and appreciate the complexities of movement control in all aspects of daily life.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5157

Requisites: Requires prerequisite of (MCEN2043 or GEEN 3024 or ASEN 1022) and (APPM2360 or MATH2130 or MATH3130) all minimum grade C. Restricted to students with 57-180 credits (Jrs/Srs) Mechanical Engineering (MCEN) and Biomedical Engineering (BMEN) majors only.

MCEN 4162 (3) Energy Conversion

Examines common energy-conversion methods and devices. Topics include power-cycle thermodynamics, turbocompressor and expander processes, combustion systems, and applications and limitations of direct energy-conversion systems.

Requisites: Requires prerequisite course of (MCEN 3012 or GEEN 3852 or AREN 2110 or EVEN 3012 or CHEN 3320) (minimum grade C). Restricted to Mechanical Engineering majors with 57+ credits only.

Additional Information: Departmental Category: Thermal

MCEN 4171 (3) Biofluids on the Micro Scale

Introduces fundamental physical concepts and basic mechanisms of biological fluids in microscale. Elaborates on the application of fluid mechanics principles to major biological systems, including human organ systems and animal locomotion in microscale. Covers physiologically relevant fluid flow phenomena on the cellular level and the underlying physical mechanisms from an engineering perspective. Related state-of-art technologies such as organ-on-a-chip and micro/nano fabrication will be emphasized. Will enhance your understanding of organ-on-a-chip technologies and their broad applications.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5171

Requisites: Requires prerequisite course of MCEN 3021 or CHEN 3200 or CVEN 3313 (all minimum grade C). Restricted to Mechanical Engineering majors only.

MCEN 4173 (3) Finite Element Analysis

Introduces the theory behind and applications of the finite element method as a general and powerful tool to model a variety of phenomena in mechanical engineering. Applications include structural mechanics, mechanics of elastic continua and heat conduction.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5173

Requisites: Requires prerequisite course of (MCEN 2063 or CVEN 3161) (minimum grade C). Restricted to Mechanical Engineering majors with 57+ credits only.

Additional Information: Departmental Category: Solids

MCEN 4174 (3) Failure of Engineering Materials

Examines the fundamental concepts regarding the failure of engineering materials. Case studies are used to integrate a basic understanding of material failure mechanisms with analysis techniques and tools. Topics include the elastic properties (isotropic and anisotropic materials) and the origin of elastic behavior, viscoelasticity, plasticity (dislocation mechanisms, yielding criteria, strengthening mechanisms), creep, fracture and fatigue.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5174

Requisites: Requires prerequisite courses of (MCEN 2024 or GEEN 3024 or ASEN 1022) and (MCEN 2063 or CVEN 3161) (all minimum grade C). Restricted to Mechanical Engineering majors with 57+ credits only.

Additional Information: Departmental Category: Materials

MCEN 4183 (3) Mechanics of Composite Materials

Introduces various kinds of composite materials, composite fabrication techniques, the physical and mechanical behavior of composites, and analytical and experimental methodologies.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5183

Requisites: Requires prerequisite courses of (MCEN 2024 or GEEN 3024 or ASEN 1022) and (MCEN 2063 or CVEN 3161) (all minimum grade C). Restricted to Mechanical Engineering majors with 57+ credits only.

Additional Information: Departmental Category: Solids

MCEN 4194 (3) Electrochemical Energy Conversion and Storage

Presents the fundamentals, principles and experimental techniques of electrochemistry, the background of ionic or electronic conduction of metal, semiconductor, inorganic and polymer materials and applications in the areas of batteries, fuel cells, electrochemical double layer capacitors, electrochemical photonics, sensors and semiconductor electrochemistry.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5194

Requisites: Requires prereq course of (MCEN 2024 or GEEN 3024 or ASEN 1022) and coreq course of MCEN 3032 (all min grade C). Restricted to Mechanical Engineering majors only.

Additional Information: Departmental Category: Materials

MCEN 4195 (3) Bioinspired Robotics

Bioinspired design views the process of how we learn from nature as an innovation strategy translating principles of function, performance, and aesthetics, from biology to human technology. The creative design process is driven by interdisciplinary exchange among engineering, biology, medicine, art, architecture and business. Diverse teams of students will collaborate on, create, and present original bioinspired design projects in the ITLL.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5195

Requisites: Restricted to students with 57-180 credits (Jrs/Srs) Mechanical Engineering (MCEN) majors only.

MCEN 4228 (1-4) Special Topics in Mechanical Engineering

Subject matter to be selected from topics of current interest.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5228

Repeatable: Repeatable for up to 15.00 total credit hours. Allows multiple enrollment in term.

Requisites: Restricted to students with 57-180 credits (Jrs/Srs) Mechanical Engineering (MCEN) majors only.

Additional Information: Departmental Category: Miscellaneous

MCEN 4238 (3) Design for Community

Design for Community (D4C) will provide engineering students with practical experience in consulting while offering valuable engineering services to University and industry clients. Focuses on preparing students for the practice of engineering by acting as a consultancy for clients' engineering-related design and fabrication needs. Students may be expected to work in teams or individually under the supervision of project directors, depending on project scope. Each student or team will assist several clients during the semester. The D4C will pursue the following goals for its students: provide a practical just-in-time learning experience for students interested in engineering consulting; prepare students for the practice of engineering design with underspecified real-world problem sets; prepare students for the professionalism needed to interact with clients; provide outreach that connects communities outside the Department of Mechanical Engineering and serves clients that would not have access to engineering

Requisites: Restricted to students with 87-180 credits (Senior, Fifth Year Senior) Mechanical Engineering majors only.

MCEN 4279 (3) Aesthetics in Design

Focuses on aesthetic aspects of design via hands-on design-build experiences. Students individually create dynamic artifacts of their own choice with the assistance of teammates. Content includes major design movements since 1900, constructive critique practice, hand sketching techniques and other selected industrial design topics. Students publish their design work on an archival public blog which provides a professional portfolio element.

Equivalent - Duplicate Degree Credit Not Granted: ATLS 4279 and MCEN 5279 and ATLS 5279

Requisites: Restricted to students with 57-180 credits (Jrs/Srs) Mechanical Engineering (MCEN) majors only.

MCEN 4291 (1-2) Project Based Learning in Rural Schools

Focuses on the use of low cost air quality monitoring tools, dubbed Pods, to implement PBL curriculum in high school environmental science classes in rural communities in Colorado. Each student will be paired with a high school class and will serve as curriculum and technology advisors as well as science experts. During the fall semester, students will be trained to effectively work in those roles and will also travel to their schools to be introduced. During the spring semester, students will support high school teachers in implementing an existing PBL air quality curriculum with the Pods. This will include monthly visits to schools in the spring and reporting back to the class. Enrollment during Fall is required for enrollment during Spring. Previously offered as a special topics course.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5291

Repeatable: Repeatable for up to 4.00 total credit hours. Allows multiple enrollment in term.

MCEN 4292 (3) Materials and Devices in Medicine

The main objective of this multidisciplinary course is to provide students with a broad survey of biomaterials and their use in medical devices for restoring or replacing the functions of injured, diseased, or aged human tissues and organs. The topics to be covered include: evolution in the medical device industry, a broad introduction to the materials used in medicine and their chemical, physical, and biological properties, discovery of medical problems, potential impacts of treatment innovations, existing devices and design considerations for several major physiological systems (cardiovascular, neuromuscular, skeletal, pulmonary, renal, dermal), materials interaction with the human body, basic mechanisms of wound healing, biocompatibility issues, testing methods and techniques in accordance with standards and relevant regulations, biofunctionalities required for specific applications, as well as state-of-the-art approaches for the development of new regenerative materials targeting cellular mechanisms. Sam

Requisites: Requires prerequisite courses of MCEN 2024 and MCEN 4117 or MCEN 5117 (all minimum grade C). Restricted to students with 87-180 credits (Senior, Fifth Year Senior) Mechanical Engineering majors only.

MCEN 4293 (3) Mechanics of Soft Matter

Provides a general overview of fundamental concepts behind the mechanical behavior of soft matter. The term soft matter (which includes polymers, colloids, liquid crystals and surfactants, to name a few) is typically used to describe classes of materials whose structural unit is much larger than atoms, making their response more complex and often richer than that of traditional solids. The objective of this class is to understand how chemical and mechanical forces between these small units yield macroscopic behaviors that one can observe in everyday life. Key engineering applications will also be discussed.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5293

Requisites: Requires prerequisite course of MCEN 2063 or CVEN 3161 (minimum grade C). Restricted to students with 87-180 credits (Senior, Fifth Year Senior) Mechanical Engineering majors only.

MCEN 4298 (3) Introduction to Polymers

Polymers represent a major class of engineering materials that are used by mechanical engineers. In this class, we will discuss the most fundamental concepts regarding polymeric materials. Topics include synthesis/manufacturing and chemical properties of polymers, statistical properties of polymer chains, multiphase polymers including polymer solutions and polymer blends, crystallization and glass transition of polymers, and viscoelastic properties of polymers.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5298

Requisites: Requires prerequisite course of MCEN 2024 (minimum grade C). Restricted to students with 57+ credits (Junior, Senior) Mechanical Engineering majors only.

MCEN 4299 (3) Household Energy Systems

Cooking, heating and lighting in the developing world often involves inefficient and incomplete combustion of solid or liquid fuels. The Global Burden of Disease Study in 2010, ranked this combustion as the 4th largest risk factor, causing 4 million premature deaths per year. There is a strong societal need to tackle this problem. Students leaving this course will be able to meet this need as they will have the skills to assess existing and new technology used in the developing world for cooking, heating and lighting. The course will cover (1) food conversion chemistry with the focus on increasing useable calories, (2) combustion and heat transfer as related to cooking, heating and lighting, and (3) combustion emissions and stove use assessment. There will be case studies interlaced throughout the content and the bulk of the workload will be homeworks and projects.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 5299

Requisites: Requires prerequisite or corequisite course of MCEN 3022 (minimum grade C). Restricted to students with 57+ credits (Junior, Senior) Mechanical Engineering or Environmental Engineering majors only.

MCEN 4700 (3) Quantum Forge I

Provides junior- and senior-level engineering and physical science students an opportunity to gain professional and technical quantum science skills and experience through participation in real-world projects in collaboration with industry leaders and academic investigators. Alongside project activity, students will engage in skill- and concept-focused modules to ensure proficiency in the skills necessary to participate in the quantum workforce. This capstone experience is intended for students who do not intend to continue on to graduate study in physics or engineering, but rather to enter the workforce directly.

Equivalent - Duplicate Degree Credit Not Granted: PHYS 4700

Requisites: Requires prerequisite course of PHYS 3330 (minimum grade C-).

Recommended: Prerequisite or corequisite PHYS 4410.

MCEN 4710 (3) Quantum Forge II

Continuation of PHYS 4700, Quantum Forge I. The Quantum Forge provides junior- and senior-level engineering and physical science students an opportunity to gain professional and technical quantum science skills and experience through participation in real-world projects in collaboration with industry leaders and academic investigators. In the second semester, students will expand upon the knowledge and skills gained through the first-semester to bring projects to a point of completion and readiness for deployment in the industry context. As with Quantum Forge I, this capstone experience is intended for students who do not intend to continue on to graduate study in physics or engineering, but rather to enter the workforce directly.

Equivalent - Duplicate Degree Credit Not Granted: PHYS 4710

Requisites: Requires prerequisite course of PHYS 4700 or MCEN 4700 (minimum grade C-).

MCEN 4848 (1-6) Independent Study

Subjects arranged in consultation with instructor and undergraduate advisor. Department consent required.

Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

Requisites: Restricted to students with 87-180 credits (Senior, Fifth Year Senior) Mechanical Engineering majors only.

Additional Information: Departmental Category: Miscellaneous

MCEN 5010 (3) Microsystems Integration

A microsystem consists of microelectronic, optoelectronic, microwave, microelectromechanical and energy components interconnected. Thermal, electrical, fabrication and assembly issues for microsystems represented by iPhone series will be studied. The packaging and interconnection technologies used to establish the design and manufacturing infrastructure of microsystems will be reviewed. Other optoelectronic, MEMS and batter components for microsystems will also be studied.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4010

Requisites: Restricted to students with 87-180 credits (Senior, Fifth Year Senior) Mechanical (MCEN) majors or College of Engineering graduate students only.

Grading Basis: Letter Grade

MCEN 5012 (3) Renewable Fuels, Fuel Cells and Internal Combustion Engines

With the accelerated availability of carbon-free and renewable fuels, we will explore high-efficiency, low-emissions fuel cell and internal combustion engine energy conversion technologies, preparing students to enter the rapidly changing fields of power and propulsion on the path to net-zero greenhouse gas emissions. Through thermodynamic modeling, systems engineering, and requirements flow-down, students will apply the fundamentals of thermodynamics, fluids and heat transfer, combustion and electrochemistry for fuel cells and IC Engines.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4012

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

MCEN 5014 (3) Energy Materials Characterization

Introduces theoretical framework for characterization techniques including X-ray diffraction, X-ray photoelectron spectroscopy and imaging methods used in the structural and morphological characterization of energy materials. Helps students determine characterization techniques suitable for their study and understand their data. Uses energy storage case studies to provide the methodologies for determining the nature and composition of materials. Helps students learn new characterization techniques from the literature and seek the characterization resources from DOE funded user facilities.

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Recommended: Prerequisite MCEN 1024 Chemistry or equivalent, and MCEN 2024 Materials Science or equivalent.

MCEN 5020 (3) Methods of Engineering Analysis 1

Studies selected topics from linear algebra, ordinary differential equations, and Fourier series. Assigns computer exercises. Correlates with analysis topics in other mechanical engineering graduate courses, and emphasizes applications.

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Math

MCEN 5021 (3) Introduction to Fluid Dynamics

Focuses on physical properties of gases and liquids, and kinematics of flow fields. Analyzes stress; viscous, heat-conducting Newtonian fluids; and capillary effects and surface-tension-driven flow. Other topics include vorticity and circulation, ideal fluid flow theory in two and three dimensions, Schwartz-Christoffel transformations, free streamline theory, and internal and free-surface waves.

Requisites: Requires corequisite course of MCEN 5020. Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Fluids

MCEN 5022 (3) Classical Thermodynamics

First and second laws of thermodynamics. Entropy and availability. Cycle analysis. Thermodynamic properties of pure substances and mixtures. Property relations. Chemical reactions and chemical availability. Energy systems analysis.

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Thermal

MCEN 5023 (3) Solid Mechanics 1

Introduces stress, strain and motion of a continuous system. Discusses material derivative; fundamental laws of mass, momentum, energy and entropy; constitutive equations and applications to elastic and plastic materials.

Equivalent - Duplicate Degree Credit Not Granted: ASEN 5012

Requisites: Requires coreq course of MCEN 5020. Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering (MCEN) majors only.

Additional Information: Departmental Category: Solids

MCEN 5024 (3) Materials Chemistry and Structures

Provides graduate level students with a comprehensive overview of the chemistry and structure of material systems, with a focus on chemical bonding, the resulting material structures and their properties. This course is intended to become one of the four core courses offered in the new Materials Science curriculum. Course topics include: bonding in solids, crystalline and amorphous states, basic group theory, diffraction, metals and alloys, ceramics, and an intro to mat. characterization.

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Materials

MCEN 5027 (1) Graduate Seminar

Offers weekly presentations by visiting speakers, faculty, and students.

Repeatable: Repeatable for up to 6.00 total credit hours.

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Miscellaneous

MCEN 5032 (3) Sustainable Energy

Examines sustainability of our current energy systems, including transportation, using environmental and economic indicators. Uses systems analysis that addresses energy supply and demand. Explores the science and technology as well as environmental and economic feasibility of efficiency measures and renewable energy technologies. Additional emphasis is given to the global nature of the challenges and the potential for locally optimal solutions.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4032

Grading Basis: Letter Grade

Additional Information: Departmental Category: Thermal

MCEN 5034 (3) Thermodynamics of Materials

Provides a unified presentation of fundamental concepts applicable to the thermodynamics of engineering materials. Develops quantitative tools for understanding the physical principles that govern phase equilibrium and transformation. Generates binary and ternary phase diagrams and determine the resulting materials structures and corresponding physical and mechanical properties.

Recommended: Prerequisites MCEN 2024 and MCEN 3012.

Additional Information: Departmental Category: Materials

MCEN 5040 (3) Methods of Engineering Analysis 2

Studies selected topics from the theory of complex variables, integral transform methods, partial differential equations, and variational methods. Assigns computer exercises. Correlates with analysis topics in other mechanical engineering graduate courses, and emphasizes applications.

Requisites: Requires prerequisite course of MCEN 5020 (minimum grade D-). Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Math

MCEN 5041 (3) Advanced Fluid Mechanics 1

Highlights exact solution of Navier-Stokes equations and fundamentals of rotating fluids. Considers Low Reynolds number flow; similarity solutions; viscous boundary layers, jets, and wakes; and unsteady viscous flow.

Requisites: Requires corequisite course of MCEN 5020. Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Fluids

MCEN 5042 (3) Heat Transfer

Studies development of equations governing transport of heat by conduction, convection, and radiation, and their solution. Includes analytical and numerical solution of initial and boundary value problems representative of heat conduction in solids. Describes heat transfer in free and forced convection, including laminar and turbulent flow. Also involves radiation properties of solids, liquids, and gases and transport of heat by radiation.

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Thermal

MCEN 5044 (3) Mechanical Behavior of Materials

This introductory-level graduate course incorporates relevant aspects of materials science, solid mechanics, thermodynamics and mathematics, and applies them to achieve a fundamental understanding of the mechanical behavior of crystalline and non-crystalline engineering materials.

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering (MCEN) majors only.

Additional Information: Departmental Category: Materials

MCEN 5045 (3) Design for Manufacturability

Topics include general design guidelines for manufacturability; aspects of manufacturing processes that affect design decisions; design rules to maximize manufacturability; economic considerations; value engineering and design for assembly. Presents case studies of successful products exhibiting DFMA principles. Prerequisite of MCEN 4026 required for undergraduate students.

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering (MCEN) majors only.

Additional Information: Departmental Category: Materials

MCEN 5055 (3) Advanced Product Design

Introduces engineering design and development of consumer products. Includes learning sketching, brainstorming, idea generation, design thinking, user-centered design, product requirements and specifications, product constraints, human factors, aesthetics, industrial design, intellectual property, concept prototyping, idea selection, tolerancing, cost estimating, design for assembly, and materials selection. Entails a semester-long team re-design of a consumer product.

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Design

MCEN 5057 (3) Environmental Modeling

Enables students to develop and evaluate pollutant transport, fate, exposure, and risk models for air, water, and multi-media systems, with a special emphasis on air. Emphasizes the fundamental physics and chemistry that govern contaminant fate and transport and the basic mathematical equations and numerical approaches for describing these processes.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4057

Grading Basis: Letter Grade

Additional Information: Departmental Category: Miscellaneous

MCEN 5064 (3) Soft Machines

Introduces soft machines as a new paradigm of engineering that starts to impact healthcare, consumer electronics, renewable energy and collaborative robotics. Prepares students to participate in research on soft machines by starting with fundamentals of soft materials and by covering soft robotics, stretchable electronics, energy harvesting and functional polymers. Includes guest lectures, a literature review and a hands-on lab project.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4046 and MSEN 5046

Requisites: Restricted to students with 87-180 credits (Senior, Fifth Year Senior) Mechanical (MCEN) majors or College of Engineering graduate students only.

Grading Basis: Letter Grade

MCEN 5065 (3) Graduate Design I

First part of a two-course graduate product design experience in mechanical engineering. Covers problem definition and specifications, determining design requirements, user feedback, alternative design concepts, engineering analysis, concept prototypes and CAD drawings. Students make several oral design reviews, a final design presentation and prepare a written report. Entails a team product design, fabrication and testing cycle of sponsored project. Students who complete this course are encouraged to take MCEN 5075 Graduate Design II.

Requisites: Requires prerequisite course of MCEN 5055 (minimum grade C).

Additional Information: Departmental Category: Design

MCEN 5075 (3) Graduate Design II

Second part of two-course graduate product design experience in mechanical engineering. Includes refinement of prototype, design optimization, fabrication, testing, and evaluation. Students orally present the final design and prepare a written report and operation manual for the product. Entails a team product design, fabrication, and testing cycle of a sponsored project, leading to a fully-functional product.

Requisites: Requires prerequisite course of MCEN 5065 (minimum grade C).

Grading Basis: Letter Grade

Additional Information: Departmental Category: Design

MCEN 5113 (3) Mechanics of Cancer

Cancer is considered to be an organ or an ecosystem, in which a critical component of the tumor microenvironment is mechanical forces. This course will cover the role of mechanics in cancer and cancer-related processes, with a focus on solid mechanics and fluid mechanics. In this course, you will apply engineering principles to come away with an appreciation of how mechanics influences cancer and its etiology as well as the development of future treatments.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4113

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical and Biomedical Engineering undergraduate majors only.

MCEN 5115 (3) Mechatronics and Robotics I

Focuses on design and construction of microprocessor-controlled electro-mechanical systems. Lectures review critical circuit topics, introduce microprocessor architecture and programming, discuss sensor and actuator component selection, robotic systems and design strategies for complex, multi-system devices. Lab work reinforces lectures and allows hands-on experience with robotic design. Students must design and build an autonomous robotic device. Project expenses may be incurred (\$50 maximum).

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4115

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Design

MCEN 5117 (3) Anatomy and Physiology for Engineers

Explores human physiological function from an engineering, specifically mechanical engineering, viewpoint. Provides an introduction to human anatomy and physiology with a focus on learning fundamental concepts and applying engineering (mass transfer, fluid dynamics, mechanics, modeling) analysis.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4117

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Miscellaneous

MCEN 5121 (3) Compressible Flow

Applies energy, continuity, and momentum principles to compressible flow. Topics include normal and oblique shocks; Prandtl-Meyer expansion; methods of characteristics; and one-, two-, and three-dimensional subsonic, supersonic, and hypersonic flows.

Requisites: Requires prerequisite course of MCEN 5021 (minimum grade D-). Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Fluids

MCEN 5122 (3) Statistical Thermodynamics

Axiomatic formulation of macroscopic thermodynamics. Quantum mechanical description of atomic and molecular structure. Statistical mechanics description of thermodynamic properties of gases, liquids and solids. Elementary kinetic theory of gases and evaluation of transport properties. Department enforced requisite: undergraduate thermodynamics.

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Thermal

MCEN 5125 (3) Optimal Design

Focuses on linear optimization and will introduce non-linear optimization. Formulating engineering applications as optimization problems that can be solved using industry known solvers will be learned. Some of these applications will include minimum cost mechanical design, wind farm power maximization, minimum energy control, production control, and more. Previous programming experience required.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4125

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Design

MCEN 5127 (3) Biomedical Ultrasound

Covers the design of ultrasound systems for medical imaging and therapy, including the physics of wave propagation, transducers, pulse-echo imaging, flow and tissue characterization, and microbubble contrast, with an emphasis on current topics in biomedical ultrasound. Includes lectures on theory, practice and special topics; a laboratory on wave propagation; oral presentations on current literature; programming exercises for data processing; and a team design project.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4127

Requisites: Restricted to graduate students only.

Grading Basis: Letter Grade

Additional Information: Departmental Category: Miscellaneous

MCEN 5131 (3) Air Pollution Control Engineering

Introduces air quality regulations, meteorology and modeling. Examines methods for controlling major classes of air pollutants, including particulate matter and oxides of sulfur and nitrogen, as well as control technology for industrial sources and motor vehicles. Requires interdisciplinary design projects.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4131

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Fluids

MCEN 5133 (3) Intro to Tissue Biomechanics

Focuses on developing an understanding of the fundamental mechanical principles that govern the response of hard and soft biological tissue to mechanical loading. Specifically, covers mechanical behavior of biological materials/tissues, classical biomechanics problems in various tissues, the relationship between molecular, cellular and physiological processes and tissue biomechanics and critical analysis of related journal articles.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4133

Additional Information: Departmental Category: Materials

MCEN 5135 (3) Wind Energy and Wind Turbine Design

Focuses on understanding and applying principles related to current wind energy technologies. Students will apply technical coursework from throughout the engineering curriculum (environmental, fluids, statics, dynamics, power, economics, etc.) to the process of designing wind turbines and wind farms. Practical, real world examples will be integrated into the lessons and problems.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4135

Requisites: Restricted to Mechanical (MCEN), Civil (CVEN) or Aerospace (ASEN) Engineering graduate students only.

Additional Information: Departmental Category: Design

MCEN 5137 (3) Anatomy and Physiology 2

Provides in-depth understandings of anatomy and physiology as well as introductions to transport phenomena, flow mechanics and solid mechanics in several organ systems: the cardiovascular, pulmonary, kidney, endocrine and digestive systems. Introduces artificial physiological systems to replace or assist physiological functions and introduce the concepts of physiological barriers that prevent diagnosis or effective therapeutics.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4137

Grading Basis: Letter Grade

Additional Information: Departmental Category: Miscellaneous

MCEN 5138 (3) Feedback Control

Introduction to fundamental principles and techniques for analysis and synthesis of feedback control systems in the time and frequency domains. Laplace transforms, transfer functions and block diagrams. Stability, dynamic response, and steady-state analysis. Analysis and design of control systems using root locus and frequency response methods. Computer aided design and analysis. Introduction to state space representations and state feedback control.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4138 ECEN 4138 or ECEN 5138

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Recommended: Prerequisite MCEN 4043 or comparable knowledge gained through outside coursework.

MCEN 5141 (3) Indoor Air Pollution

Describes the impact of indoor air pollutants on human health, including an introduction to key pollutants and their sources. Students will estimate emission factors, calculate generation/ventilation rates, quantify the impact of deposition and chemical reactions and explore relevant control technology. Current issues will also be addressed, including climate change, green building design, economic concerns and relevance to the developing world.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4141

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Fluids

MCEN 5147 (3) Mechanobiology

Studies how mechanical forces modulate the morphological and structural fitness of biological tissues. Current molecular mechanisms by which cells convert mechanical stimulus into chemical activity and the literature supporting them will be discussed. Students will acquire an understanding and expertise from the analysis of primary literature and completion of a synthesis project.

Requisites: Restricted to students with 87-180 credits (Senior, Fifth Year Senior) Mechanical (MCEN) majors or College of Engineering graduate students only.

Grading Basis: Letter Grade

MCEN 5151 (3) Flow Visualization

Explores techniques for the visualization of the physics of fluid flows including seeding with dyes, particles and bubbles, and shadowgraphy and schlieren. Reviews optics and fluid physics, especially atmospheric clouds. Assignments are student-driven, to individuals and mixed teams of graduates, undergraduates, engineering majors and photography/video majors.

Equivalent - Duplicate Degree Credit Not Granted: CINE 4200, MCEN 4151, ARTF 5200, ATLS 4151 and ATLS 5151

Additional Information: Departmental Category: Fluids

MCEN 5152 (3) Introduction to Combustion

Focuses on the mechanisms by which fuel and oxidizers are converted into combustion products. Application to practical combustion devices such as Otto, Diesel, gas turbine and power plant combustion systems. Consideration of combustion-generated air pollution, fire safety and combustion efficiency.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4152

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Thermal

MCEN 5153 (3) Introduction to Fracture Mechanics

This course will introduce fundamental concepts, analytical approaches, and experimental methods to characterize the fracture of solid materials. Topics to be discussed include: linear elastic analysis of 2D cracks, energy flows and criteria for elastic fracture, experimental methods for elastic fracture, application of fracture mechanics in adhesion, introduction to elastic plastic fracture, and nonlinear fracture mechanics of soft materials.

Requisites: Requires prerequisite course of MCEN 2063 or CVEN 3161 or MCEN 5023 or ASEN 5012 (all minimum grade C).

MCEN 5154 (3) Biocolloids and Biomembranes

Covers the thermodynamics and mechanics of biological membranes and biomedical colloids. Considers intermolecular and surface forces, self-assembly and colloidal stability. Addresses structure-property relationships and design principles for biomedical applications. Focuses on monolayers, bilayers, micelles, filomicelles, liposomes, polymersomes, emulsions, microbubbles, polyplexes and polyelectrolyte multilayer capsules.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4154

Recommended: Prerequisites APPM 2360 and PHYS 1120.

Grading Basis: Letter Grade

Additional Information: Departmental Category: Materials

MCEN 5155 (3) Automated Mechanical Design Synthesis

Introduces computational approaches to automatically generate complex multimaterial mechanical designs that satisfy predefined high-level specifications, discusses algorithms to solve design as a constrained non-convex multi-objective optimization problem. Topics: expert-driven design process; computational analysis tools based on mechanical simulation (finite element methods, mesh-free methods); topological optimization; compositional design; multi-objective optimization; evolutionary design; design for manufacturing with additives (FDM, SLA, Inkjet). Students design a part to specifications, fabricate using advanced (3D printing, laser cutting, CNC, etc) tools.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4155

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Recommended: Prerequisite students should be comfortable with MATLAB, PDEs, linear algebra, free body diagrams, mechanical modeling/design; exposure to finite-element modeling and state-space representations.

MCEN 5157 (3) Modeling of Human Movement

Human movement analysis is used in physical rehabilitation, sport training, human-robot interaction, animation, and more. Course provides a systematic overview of human movement on multiple levels of analysis, with an emphasis on the phenomenology amenable to computational modeling. Covers muscle physiology, movement-related brain areas, musculoskeletal mechanics, forward and inverse dynamics, optimal control and Bayesian inference, learning and adaptation. Inspires students to see and appreciate the complexities of movement control in all aspects of daily life.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4157

Requisites: Restricted to graduate students in the College of Engineering and Applied Science or undergraduate Mechanical Engineering (MCEN) and Biomedical Engineering (BMEN) majors with 57+ credits (Junior or Senior).

MCEN 5161 (3) Aerosols

Introduces atmospheric aerosols and properties of their distributions, followed by fundamental descriptions of single particle dynamics, thermodynamics, nucleation, coagulation, mass transfer and populations dynamics. During the second half of the course, the focus will shift to sources and sinks of atmospheric aerosols, their impacts on atmospheric chemistry and radiation, and the impacts of these processes on air quality and climate.

Requisites: Restricted to graduate students only.

Additional Information: Departmental Category: Fluids

MCEN 5171 (3) Biofluids on the Micro Scale

Introduces fundamental physical concepts and basic mechanisms of biological fluids in microscale. Elaborates on the application of fluid mechanics principles to major biological systems, including human organ systems and animal locomotion in microscale. Covers physiologically relevant fluid flow phenomena on the cellular level and the underlying physical mechanisms from an engineering perspective. Related state-of-art technologies such as organ-on-a-chip and micro/nano fabrication will be emphasized. Will enhance your understanding of organ-on-a-chip technologies and their broad applications.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4171

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

MCEN 5173 (3) Finite Element Analysis

Introduces the theory behind and applications of the finite element method as a general and powerful tool to model a variety of phenomena in mechanical engineering. Applications include structural mechanics, mechanics of elastic continua and heat conduction.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4173

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Solids

MCEN 5174 (3) Failure of Engineering Materials

Examines the fundamental concepts regarding the failure of engineering materials. Case studies are used to integrate a basic understanding of material failure mechanisms with analysis techniques and tools. Topics include the elastic properties (isotropic and anisotropic materials) and the origin of elastic behavior, viscoelasticity, plasticity (dislocation mechanisms, yielding criteria, strengthening mechanisms), creep, fracture and fatigue.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4174

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Materials

MCEN 5183 (3) Mechanics of Composite Materials

Introduces various kinds of composite materials, composite fabrication techniques, the physical and mechanical behavior of composites, and analytical and experimental methodologies.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4183

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Solids

MCEN 5194 (3) Electrochemical Energy Conversion and Storage

Presents the fundamentals, principles and experimental techniques of electrochemistry, the background of ionic or electronic conduction of metal, semiconductor, inorganic and polymer materials and applications in the areas of batteries, fuel cells, electrochemical double layer capacitors, electrochemical photonics, sensors and semiconductor electrochemistry.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4194

Recommended: Prerequisites MCEN 2024 and MCEN 3032.

Grading Basis: Letter Grade

Additional Information: Departmental Category: Materials

MCEN 5195 (3) Bioinspired Robotics

Bioinspired design views the process of how we learn from nature as an innovation strategy translating principles of function, performance, and aesthetics, from biology to human technology. The creative design process is driven by interdisciplinary exchange among engineering, biology, medicine, art, architecture and business. Diverse teams of students will collaborate on, create, and present original bioinspired design projects in the ITLL.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4195

Requisites: Restricted to graduate students in the College of Engineering and Applied Science or undergraduate Mechanical Engineering (MCEN) majors with 57+ credits (Junior or Senior).

MCEN 5208 (1-4) Special Topics

Credit hours and subject matter to be arranged.

Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Miscellaneous

MCEN 5228 (1-4) Special Topics in Mechanical Engineering

Subject matter to be selected from topics of current interest.

Repeatable: Repeatable for up to 30.00 total credit hours. Allows multiple enrollment in term.

Requisites: Restricted to graduate students in the College of Engineering and Applied Science or undergraduate Mechanical Engineering (MCEN) majors with 57+ credits (Junior or Senior).

Additional Information: Departmental Category: Miscellaneous

MCEN 5255 (3) Design for Mfg

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Design

MCEN 5258 (1-3) Sp Tpcs-Combustion Seminar

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Special Topics

MCEN 5279 (3) Aesthetics in Design

Focuses on aesthetic aspects of design via hands-on design-build experiences. Students individually create dynamic artifacts of their own choice with the assistance of teammates. Content includes major design movements since 1900, constructive critique practice, hand sketching techniques and other selected industrial design topics. Students publish their design work on an archival public blog which provides a professional portfolio element.

Equivalent - Duplicate Degree Credit Not Granted: ATLS 5279 and

MCEN 4279 and ATLS 4279

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

MCEN 5291 (1-2) Project Based Learning in Rural Schools

Focuses on the use of low cost air quality monitoring tools, dubbed Pods, to implement PBL curriculum in high school environmental science classes in rural communities in Colorado. Each student will be paired with a high school class and will serve as curriculum and technology advisors as well as science experts. During the fall semester, students will be trained to effectively work in those roles and will also travel to their schools to be introduced. During the spring semester, students will support high school teachers in implementing an existing PBL air quality curriculum with the Pods. This will include monthly visits to schools in the spring and reporting back to the class. Enrollment during Fall is required for enrollment during Spring. Previously offered as a special topics course.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4291

Repeatable: Repeatable for up to 4.00 total credit hours. Allows multiple enrollment in term.

MCEN 5292 (3) Materials and Devices in Medicine

The main objective of this multidisciplinary course is to provide students with a broad survey of biomaterials and their use in medical devices for restoring or replacing the functions of injured, diseased, or aged human tissues and organs. The topics to be covered include: evolution in the medical device industry, a broad introduction to the materials used in medicine and their chemical, physical, and biological properties, discovery of medical problems, potential impacts of treatment innovations, existing devices and design considerations for several major physiological systems (cardiovascular, neuromuscular, skeletal, pulmonary, renal, dermal), materials interaction with the human body, basic mechanisms of wound healing, biocompatibility issues, testing methods and techniques in accordance with standards and relevant regulations, biofunctionalities required for specific applications, as well as state-of-the-art approaches for the development of new regenerative materials targeting cellular mechanisms. Rec

Requisites: Requires prerequisite course of MCEN 4117 or MCEN 5117 (minimum grade C). Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

MCEN 5293 (3) Mechanics of Soft Matter

Provides a general overview of fundamental concepts behind the mechanical behavior of soft matter. The term soft matter (which includes polymers, colloids, liquid crystals and surfactants, to name a few) is typically used to describe classes of materials whose structural unit is much larger than atoms, making their response more complex and often richer than that of traditional solids. The objective of this class is to understand how chemical and mechanical forces between these small units yield macroscopic behaviors that one can observe in everyday life. Key engineering applications will also be discussed.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4293

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Recommended: Prerequisite knowledge comparable to that gained through MCEN 2063.

MCEN 5298 (3) Introduction to Polymers

Polymers represent a major class of engineering materials that are used by mechanical engineers. In this class, we will discuss the most fundamental concepts regarding polymeric materials. Topics include synthesis/manufacturing and chemical properties of polymers, statistical properties of polymer chains, multiphase polymers including polymer solutions and polymer blends, crystallization and glass transition of polymers, and viscoelastic properties of polymers.

Equivalent - Duplicate Degree Credit Not Granted: MCEN 4298

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Recommended: Prerequisite knowledge comparable to that gained through MCEN 2024.

MCEN 5299 (3) Household Energy Systems

Cooking, heating and lighting in the developing world often involves inefficient and incomplete combustion of solid or liquid fuels. The Global Burden of Disease Study in 2010, ranked this combustion as the 4th largest risk factor, causing 4 million premature deaths per year. There is a strong societal need to tackle this problem. Students leaving this course will be able to meet this need as they will have the skills to assess existing and new technology used in the developing world for cooking, heating and lighting. The course will cover (1) food conversion chemistry with the focus on increasing useable calories, (2) combustion and heat transfer as related to cooking, heating and lighting, and (3) combustion emissions and stove use assessment. There will be case studies interlaced throughout the content and the bulk of the workload will be homeworks and projects. Recommended prerequisite: knowledge comparable to that gained through MCEN 3022 or concurrent enrollment in MC

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering or Environmental Engineering undergraduate majors only.

MCEN 5448 (3) Linear Systems

Introduces the theory of linear systems, including state space descriptions of dynamic systems, linear spaces, linear mappings, structure of linear operators, stability, controllability, observability, state variable estimation and feedback control methods.

Equivalent - Duplicate Degree Credit Not Granted: ECEN 5448

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Recommended: Prerequisite MCEN 4138 or MCEN 5138 and strong foundational knowledge of linear algebra and differential equations.

MCEN 5488 (3) Geometric Control Theory

Introduce geometric approaches to study dynamical control systems over manifolds. Cover fundamental control-theoretical results, such as controllability, observability, feedback stabilizability, symmetries and group actions, that are beyond linear control systems. Establish connections between control theory and mathematics, especially topology, differential geometry, Lie groups and Lie algebras. Final project focuses on engineering applications related to students' own research interests.

Equivalent - Duplicate Degree Credit Not Granted: ECEN 5488

MCEN 5498 (3) Stochastic Control Theory

Introduce a toolbox for dealing with stochastic control systems. Cover topics such as stochastic calculus, linear and nonlinear filtering, and dynamic programming. Discuss system theoretic issues and derive optimal control laws for a variety of stochastic control problems, including, e.g., the separation principle for Linear-quadratic-Gaussian problems. Final project focuses on engineering applications related to students' own research interests.

Equivalent - Duplicate Degree Credit Not Granted: ECEN 5498

MCEN 5636 (3) Micro-Electro-Mechanical Systems 1

Addresses issues of micro-electro-mechanical systems (MEMS) modeling, design, and fabrication. Emphasizes the design and fabrication of sensors and actuators due to significance of these devices in optics, medical instruments, navigation components, communications, and robotics. Department consent required.

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Manufacturing and Systems

MCEN 5832 (3) Special Topics

Additional Information: Departmental Category: Special Topics

MCEN 5848 (1-6) Independent Study

Available only through approval of graduate advisor. Subjects arranged to fit the needs of the particular student. May be repeated for up to 6 total credits.

Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

Requisites: Restricted to College of Engineering graduate students only.

Additional Information: Departmental Category: Miscellaneous

MCEN 5858 (1-6) Independent Study

Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

Additional Information: Departmental Category: Miscellaneous

MCEN 5868 (1-3) Independent Study

Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

Additional Information: Departmental Category: Miscellaneous

MCEN 5878 (1-3) Independent Study

Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

Additional Information: Departmental Category: Miscellaneous

MCEN 5888 (1-3) Independent Study

Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

Additional Information: Departmental Category: Miscellaneous

MCEN 5930 (1-3) Professional Internship

This class provides a structure for Mechanical Engineering graduate students to receive academic credit for internships with industry partners that have an academic component to them suitable for graduate-level work. Participation in the program will consist of an internship agreement between a student and an industry partner who will employ the student in a role that supports the academic goals of the internship. Instructor participation will include facilitation of mid-term and final assessments of student performance as well as support for any academic-related issues that may arise during the internship period. May be taken during any term following initial enrollment and participation in ME graduate programs. Department permission required to enroll.

Repeatable: Repeatable for up to 6.00 total credit hours.

Requisites: Restricted to Mechanical Engineering graduate students only.

MCEN 6001 (3) Reacting Flows

Provides an introduction to reacting flows and combustion. Covers chemical kinetics, including global and detailed mechanisms and the variable density flow equations are derived. Relevant non-dimensional parameters and limiting behaviors are discussed. The Rankine-Hugoniot relations are presented and various aspects of diffusion, kinetically dominated and balanced combustion are outlined. Flame structures are discussed, including laminar and turbulent flames, and the Burke-Schumann solution is outlined. The turbulent forms of the motion equations are derived, and the reactive scalar transport equation and mixture fraction variable are presented. The flamelet progress variable approach is outlined, including a comparison of steady and unsteady flamelet models. Specific topics in spray combustion, triple flames, solid-gas reactors and detonations are discussed.

Equivalent - Duplicate Degree Credit Not Granted: ASEN 6001

Requisites: Requires prerequisite course of MCEN 5021 (minimum grade C-). Restricted to College of Engineering and Applied Science graduate students or BS/MS Concurrent Degree Students only.

Additional Information: Departmental Category: Fluids

MCEN 6184 (3) Structure and Properties of Polymers

Emphasizes the relationships between molecular structures and macroscopic properties of polymers. Structural aspects include chain conformation, configuration, and the crystalline and amorphous states. Discusses physical, mechanical and dynamic properties with a focus on solution and phase behavior, transitions of bulk polymers, and rubber and viscoelastic behavior.

Requisites: Restricted to College of Engineering graduate students only.

Recommended: Prerequisite an intro-level polymer course.

Additional Information: Departmental Category: Materials

MCEN 6228 (1-4) Special Topics in Mechanical Engineering

Subject matter to be selected from topics of current interest.

Repeatable: Repeatable for up to 15.00 total credit hours. Allows multiple enrollment in term.

Requisites: Restricted to College of Engineering graduate students only.

Additional Information: Departmental Category: Special Topics

MCEN 6848 (1-6) Independent Study

Available only through approval of graduate advisor. Subjects arranged to fit the needs of the particular student.

Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

Requisites: Restricted to graduate students only.

Additional Information: Departmental Category: Miscellaneous

MCEN 6858 (1-6) Independent Study

Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

Additional Information: Departmental Category: Miscellaneous

MCEN 6868 (1-6) Independent Study

Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

Additional Information: Departmental Category: Miscellaneous

MCEN 6878 (1-6) Independent Study

Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

Additional Information: Departmental Category: Miscellaneous

MCEN 6888 (1-6) Independent Study

Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

Additional Information: Departmental Category: Miscellaneous

MCEN 6949 (1) Master's Candidate for Degree

Registration intended for students preparing for a thesis defense, final examination, culminating activity, or completion of degree.

Additional Information: Departmental Category: Thesis

MCEN 6959 (1-6) Master's Thesis

Additional Information: Departmental Category: Thesis

MCEN 7221 (3) Turbulence

Hydrodynamic stability theory, equations for turbulent flows, free shear flows and boundary layers, homogeneous and isotropic turbulence, overview of turbulent combustion, reaction kinetics, energy equation, Favre averaging, Pdfs, premixed and nonpremixed flame modeling, and recent developments.

Requisites: Restricted to any College of Engineering and Applied Science graduate students or to Mechanical Engineering undergraduate majors only.

Additional Information: Departmental Category: Fluids

MCEN 7228 (3) Special Topics

Additional Information: Departmental Category: Special Topics

MCEN 8999 (1-10) Doctoral Dissertation

Additional Information: Departmental Category: Thesis