MECHANICAL ENGINEERING (M E)

M E 1 – COOPERATIVE EDUCATION PROGRAM
1 credit.

Work experience which combines classroom theory with practical knowledge of operations to provide students with a background upon which to base a professional career in industry.
Requisites: Sophomore standing
Course Designation: Workplace - Workplace Experience Course
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2025
Learning Outcomes: 1. Identify and respond appropriately to real-life engineering ethics cases relevant to co-op work
Audience: Undergraduate

2. Synthesize and apply appropriate technical education to real world technical work
Audience: Undergraduate

3. Communicate effectively in writing and speaking with a range of audiences in the workplace, including those without disciplinary expertise
Audience: Undergraduate

4. Develop professional and transferable habits like time management skills, collaborative problem-solving skills, and research skills for learning new information
Audience: Undergraduate

M E 160 – ARCHITECTURAL GRAPHICS
3 credits.

The skill of communicating through the graphic media of freehand and instrumental drawing. Architectural presentation, isometric, perspective and shades and shadows.
Requisites: None
Repeatable for Credit: No
Last Taught: Fall 2018

M E 201 – INTRODUCTION TO MECHANICAL ENGINEERING
3 credits.

Provides an introduction to the field of Mechanical Engineering in the context of a major, semester-long project that is carried out in small groups as well as several, smaller hands-on projects. Obtain a shop pass, design build and test small prototypes using the shop as well as 3-D printing, take measurements using various instruments, and use a microcontroller to control a system. Introduction to software that is particularly useful to Mechanical Engineers including SolidWorks and EES. Learn how to design experiments, obtain data, use data to develop simple models of systems, exercise models for the purposes of design, and present their results professionally. It will provide a context for the math, physics and chemistry classes that are taken during the first year of the Mechanical Engineering curriculum and also provide a preview of future ME courses and should also give you a glimpse into the breadth of opportunities afforded by a mechanical engineering degree.
Requisites: Declared in Biomedical, Biological Systems, Chemical, Civil, Computer, Electrical, Environmental, Geological, Industrial, Mechanical, or Nuclear Engineering, Materials Science and Engineering, Engineering Physics, or Engineering Mechanics
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Measure an electrical signal using digital equipment
Audience: Undergraduate

2. Calculate resolution of an electrical signal measurement
Audience: Undergraduate

3. Design a component to execute a specified task
Audience: Undergraduate

4. Construct a prototype based on a design
Audience: Undergraduate

5. Interpret test data from a test or experiment
Audience: Undergraduate

6. Solve a quantitative engineering problem using computer tools
Audience: Undergraduate

M E 231 – GEOMETRIC MODELING FOR DESIGN AND MANUFACTURING
3 credits.

Introduction to basic methods and fundamental concepts in geometric description and modeling of mechanical form, components, and assemblies. Topics include elements of descriptive geometry, engineering drawing standards, introduction to computer modeling, and geometric dimensioning and tolerancing (GDT). Lectures are reinforced by the laboratory experience where students operate modern commercial computer-aided design systems to model and to learn the basics of engineering communication, specification, and annotation.
Requisites: Declared in Biomedical, Biological Systems, Chemical, Civil, Computer, Electrical, Environmental, Geological, Industrial, Mechanical or Nuclear Engineering, Mat Sci and Engin, Engin Physics, Engineering Mechanics or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Summer 2025
Learning Outcomes: 1. Model fully-constrained, three-dimensional engineering components using software
Audience: Undergraduate

2. Model the assembly of three-dimensional components
Audience: Undergraduate

3. Predict mechanical motion of a mechanism in an assembly
Audience: Undergraduate

4. Apply geometric dimensioning and tolerancing to components and assemblies
Audience: Undergraduate

5. Solve simple descriptive geometry and orthographic projection problems
Audience: Undergraduate

6. Apply engineering dimensions to a component and create engineering drawings
Audience: Undergraduate

7. Solve tolerance stack-up for parts/assemblies on an engineering drawing
Audience: Undergraduate

M E 240 – DYNAMICS
3 credits.

Rectilinear and curvilinear motion of a particle; force, mass, acceleration; work, potential, and kinetic energy; impulse and momentum; kinematics of rigid bodies; moving coordinate systems with relative motion; general planar rigid body kinematics and kinetics. Applications to linkages, cams and geared systems.
Requisites: E M A 201 and MATH 222, or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Summer 2024
Learning Outcomes: 1. Derive kinematic relationships among position, velocity and acceleration for systems of particles and rigid bodies
Audience: Undergraduate

2. Apply and solve Newton-Euler equations to analyze the motion of systems of particles and rigid bodies
Audience: Undergraduate

3. Apply and solve work-energy equations to analyze the motion of systems of particles and rigid bodies
Audience: Undergraduate

4. Apply and solve momentum equations to analyze the motion of systems of particles and rigid bodies
Audience: Undergraduate

M E 273 – ENGINEERING PROBLEM SOLVING WITH EES
1 credit.

This course will serve the dual purpose of providing students with a high level of proficiency in the Engineering Equation Solver software as well as giving students the opportunity to solve high-level engineering problems using this tool. Students leaving the course will have a very solid understanding of equation solving software including advanced features that would not be covered in any other class on campus. Students will also get another opportunity to apply sophisticated computing tools to engineering applications.
Requisites: MATH 222 or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Summer 2025
Learning Outcomes: 1. Solve engineering problems involving multiple, non-linear algebraic equations
Audience: Undergraduate

2. Analyze data to visualize time dependent solutions
Audience: Undergraduate

3. Apply numerical integration schemes to one-dimensional steady-state and transient problems
Audience: Undergraduate

4. Solve complex engineering problems using numerical methods
Audience: Undergraduate

M E 291 – UNDERGRADUATE MECHANICAL ENGINEERING PROJECTS
1-3 credits.

Individual lab projects under staff supervision.
Requisites: Consent of instructor
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2025
Learning Outcomes: 1. Apply basic physical and mathematical principles to engineering research problems
Audience: Undergraduate

2. Communicate technical concepts to a diverse audience via verbal or written media
Audience: Undergraduate

M E 299 – INDEPENDENT STUDY
1-3 credits.

Directed study projects as arranged with instructor.
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2025
Learning Outcomes: 1. Apply basic physical and mathematical principles to complete an engineering project
Audience: Undergraduate

2. Apply basic mechanical engineering principles to complete an engineering project
Audience: Undergraduate

3. Communicate technical concepts to a diverse audience via verbal or written media
Audience: Undergraduate

M E 306 – MECHANICS OF MATERIALS
3 credits.

Stress and strain, torsion, bending of beams, shearing stresses in beams, compound stresses, principal stresses, deflections of beams, statically indeterminate members, columns.
Requisites: E M A 201 and MATH 222, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Summer 2024
Learning Outcomes: 1. analyze stress, strain, and deflection of structures subjected to tension, compression, torsion, and bending
Audience: Undergraduate

2. predict failure of materials and structures
Audience: Undergraduate

3. identify the assumptions required to solve a mechanics problem
Audience: Undergraduate

4. interpret written derivations of key mechanics equations
Audience: Undergraduate

5. develop practices for independent learning and study
Audience: Undergraduate

M E/E M A 307 – MECHANICS OF MATERIALS LAB
1 credit.

Data processing, tension/compression tests, creep stress concentrations, fatigue, fracture, composite materials, combined stress, beam flexure, dynamic loads, buckling.
Requisites: (M E 306, E M A 303 or concurrent enrollment) or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Summer 2025
Learning Outcomes: 1. Perform a tensile test
Audience: Undergraduate

2. Calculate material properties from tensile test data
Audience: Undergraduate

3. Compare experimentally determined values to theoretical values
Audience: Undergraduate

4. Plot experimental data in an efficient and effective manner
Audience: Undergraduate

5. Identify sources of error and uncertainty in mechanical tests
Audience: Undergraduate

M E 310 – MANUFACTURING: POLYMER PROCESSING AND ENGINEERING
3 credits.

Introduction to all important aspects of polymer processing and engineering including polymeric materials, material properties, design and manufacturing considerations, processing methods, part performance, post-consumer recycling and upcycling, societal responsibilities and ethics, and various techniques for modeling in materials processing like dimensional analysis, design of experiments, analytical solutions, and computer simulation.
Requisites: (M E 306 or E M A 303) and M E 231
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Describe the relationship among materials, properties, processes, and performance of plastics products
Audience: Undergraduate

2. Describe polymer processes, process selection, and optimal design and apply the basic terminology associated with the field of polymer processing and manufacturing
Audience: Undergraduate

3. Conduct experiments, analyze and interpret the data
Audience: Undergraduate

4. Identify techniques and decision making tools for increased quality, product safety, decreased cost, reduced cycle times and reliability and productivity
Audience: Undergraduate

5. Identify ethical and sustainability concerns that arise in manufacturing
Audience: Undergraduate

M E 311 – MANUFACTURING: METALS AND AUTOMATION
3 credits.

An introduction to processes for manufacturing metal parts, designing parts to make them easier to manufacture with these methods, and approaches for increasing productivity. Manufacturing automation, control, and metrology for increased safety, productivity, and part quality. Engineering economics for determining the cost of manufacturing a part.
Requisites: (M S & E 350, 351, or 352 or declared in Biological Systems Engineering: Machinery Systems BS), M E 231, and (M E 306 or E M A 303)
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Take an engineering drawing or CAD model of a part and develop a production method for making the part
Audience: Undergraduate

2. Design with manufacturing in mind so their designs are inherently easy/economical to produce
Audience: Undergraduate

3. Improve manufacturing of products in terms of rates and quantities (w.r.t. profitability)
Audience: Undergraduate

4. Improve manufacturing of products in terms of quality and repeatability (w.r.t. part functionality)
Audience: Undergraduate

5. Describe the impact of manufacturing on the economy, society, and the environment
Audience: Undergraduate

6. Identify ethical concerns that arise in manufacturing
Audience: Undergraduate

M E 313 – MANUFACTURING PROCESSES
3 credits.

A quantitative and qualitative study of manufacturing processes including machining, extrusion, sheet metal forming, welding, and casting for metals; and additive manufacturing, extrusion, injection molding, thermoforming and blow molding for plastics. Emphasis on process selection for optimum design. Laboratory experiments and demonstrations. Quality, strength, and economic evaluations.
Requisites: (M S & E 350, 351, or 352) or (declared in Biological Systems Engineering: Machinery Systems, BS and M E 306 or E M A 303)
Repeatable for Credit: No
Last Taught: Spring 2021
Learning Outcomes: 1. Articulate that manufacturing is necessary to bring a design on paper into being and that failing to efficiently manufacture a product will make it uneconomical and ultimately a failure
Audience: Undergraduate

2. Articulate that the field of manufacturing contains a huge number of processes with varying capabilities in terms of quality and quantity of products produced
Audience: Undergraduate

3. Apply the criteria used to select a manufacturing process, including: production quantity, price point, geometry, material, and part functionality
Audience: Undergraduate

4. Articulate the importance of design for manufacturability
Audience: Undergraduate

5. Recognize the strong interrelationships between material properties and manufacturing processes
Audience: Undergraduate

6. Produce products using basic manufacturing processes, gaining a sense of accomplishment in having personally made a product
Audience: Undergraduate

7. Describe the breadth of the field of polymer processing and the most important polymer processing techniques, including process selection and optimum design
Audience: Undergraduate

8. Apply the basic terminology associated with these fields
Audience: Undergraduate

9. Recognize the strong interrelationships between material properties and polymer processing processes
Audience: Undergraduate

10. Demonstrate understanding of concepts from the lecture in the labs, including polymer processes like: Thermoforming, Compounding, Extrusion, Injection Molding and Additive Manufacturing
Audience: Undergraduate

11. Describe opportunities for sustainability in polymer processing and polymer product design
Audience: Undergraduate

M E 314 – MANUFACTURING FUNDAMENTALS
3 credits.

An introduction to techniques for modeling in materials processing and improving decision making in increasing the productivity of design and manufacturing processes. Quality improvement and engineering simulation tools are presented as well as the methods of engineering economy and the role of manufacturing automation and systems, through lectures and laboratories.
Requisites: M E 313 and (M E 340 or concurrent enrollment)
Repeatable for Credit: No
Last Taught: Fall 2022

M E 331 – COMPUTER-AIDED ENGINEERING
3 credits.

Introduction to the fundamentals of Computer Aided Engineering. Topics include mathematical and programmable methods for modeling and design of mechanical shapes and assemblies; shape processing for manufacturing, including NC machining and 3D printing; and computer-aided analysis of structural, thermal and other physical properties.
Requisites: M E 231, (MATH 320, 340, 341, or 375), (M E 306 or E M A 303 or concurrent enrollment), (M E 240 or E M A 202), and (COMP SCI 200, 220, 300, 301, 310, or placement into COMP SCI 300), or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Summer 2025
Learning Outcomes: 1. comprehend Computer Aided Design (CAD) concepts such as 3D transformations, parametric curves and surfaces
Audience: Undergraduate

2. comprehend Computer Aided Engineering (CAE) concepts such as structural loads, restraints, and finite element analysis
Audience: Undergraduate

3. demonstrate ability to use CAD software for designing curves and surfaces
Audience: Undergraduate

4. demonstrate ability to use CAE software for structural and thermal analysis
Audience: Undergraduate

5. demonstrate ability to use CAE software for optimizing mechanical components
Audience: Undergraduate

M E 340 – DYNAMIC SYSTEMS
3 credits.

Mathematical modeling and analysis of dynamic systems with mechanical, thermal, and fluid elements. Topics: time domain solutions, analog computer simulation, linearization techniques, block diagram representation, numerical methods and frequency domain solutions. Students are assumed to have basic competence in particle and planar rigid body dynamics, matrix and vector algebra, and linear differential equations.
Requisites: (M E 240 or E M A 202) and (MATH 319, 320, or 375), or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Summer 2025
Learning Outcomes: 1. Develop linear differential equations for mechanical, electrical, fluid, and thermal systems
Audience: Undergraduate

2. Solve linear differential equations using Laplace transform methods and numerical techniques
Audience: Undergraduate

3. Derive transfer functions and evaluate the system output response for impulse, step, and ramp input
Audience: Undergraduate

4. Create frequency response diagrams for various first and second-order transfer functions
Audience: Undergraduate

5. Calculate steady-state error and PID characteristics for simple feedback control systems
Audience: Undergraduate

M E 342 – DESIGN OF MACHINE ELEMENTS
3 credits.

Analysis and design of machine elements and machines; loads, stresses, deflections, material selection, fatigue failure, finite elements; mechanical power transmission components including gearing, bearings, shafting, and frictional devices.
Requisites: (M E 306 or E M A 303) and (M E 331, B M E 201, or concurrent enrollment or declared in Biological Systems Engineering), or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Sketch failure envelopes for both brittle and ductile static failure theories and use these to estimate safety factor against potential static stress failure
Audience: Undergraduate

2. Calculate safety factor for high cycle fatigue of steel components
Audience: Undergraduate

3. Assess safety factor for straight cut spur gears against bending and surface fatigue failure
Audience: Undergraduate

4. Predict the failure rate of components based on property and load distributions and estimate the cost of these failures in terms of human life and limb
Audience: Undergraduate

5. Quantify specifications of belt and pulley systems for successful transmission of power between parallel shafts
Audience: Undergraduate

6. Quantify specifications of rolling element bearings for successful shaft support
Audience: Undergraduate

M E 349 – ENGINEERING DESIGN PROJECTS
3 credits.

Applied engineering design projects. Emphasis on design of practical mechanical engineering systems, devices and/or components. Two 2-hr labs and one lecture per week. Lecture focuses on the design process, creativity, patents, and other applications to practical problems.
Requisites: Declared in Mechanical Engineering with senior standing and M E 331
Repeatable for Credit: No
Last Taught: Spring 2020
Learning Outcomes: 1. Define an engineering problem as it relates to clients and stakeholders, and translate stakeholder requirements into engineering specifications
Audience: Undergraduate

2. Research previous solutions to similar design problems
Audience: Undergraduate

3. Identify potentially relevant standards to design problems
Audience: Undergraduate

4. Work together on a team that fosters inclusiveness, delegate responsibility, and plan tasks and monitors effort to better achieve objectives that meet client requirements
Audience: Undergraduate

5. Build an effective physical or analytical prototype
Audience: Undergraduate

6. Communicate design progress in written and oral format
Audience: Undergraduate

7. Defend design decisions with engineering calculations
Audience: Undergraduate

M E 351 – INTERDISCIPLINARY EXPERIENTIAL DESIGN PROJECTS I
3 credits.

First of a two-course sequence (M E 351 and 352) in which students design and fabricate systems and devices, typically having an interdisciplinary aspect. In the first course, emphasis will be on project planning, team dynamics, problem identification, and conceptual design and evaluation.
Requisites: Declared in Mechanical Engineering with senior standing and M E 331
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Define an engineering problem as it relates to clients and stakeholders, and translate stakeholder requirements into engineering specifications
Audience: Undergraduate

2. Research previous solutions to similar design problems
Audience: Undergraduate

3. Identify potentially relevant standards to design problem
Audience: Undergraduate

4. Work together on an team that fosters inclusiveness, delegates responsibility, and plans tasks and monitors effort to better achieve objectives that meet client requirements
Audience: Undergraduate

5. Build an effective physical or analytical prototype
Audience: Undergraduate

6. Present design progress in written and oral format
Audience: Undergraduate

7. Defend design decisions with engineering calculations
Audience: Undergraduate

M E 352 – INTERDISCIPLINARY EXPERIENTIAL DESIGN PROJECTS II
3 credits.

Design and fabricate systems and devices, typically having an interdisciplinary aspect. Emphasis will be on detailed design, fabrication, testing, and modification of concepts developed in the previous course (M E 351).
Requisites: Senior standing and M E 351
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Define an engineering problem as it relates to clients and stakeholders, and translate stakeholder requirements into engineering specifications
Audience: Undergraduate

2. Research previous solutions to similar design problems
Audience: Undergraduate

3. Identify potentially relevant standards to design problem
Audience: Undergraduate

4. Work together on an team that fosters inclusiveness, delegates responsibility, and plans tasks and monitors effort to better achieve objectives that meet client requirements
Audience: Undergraduate

5. Build an effective physical or analytical prototype
Audience: Undergraduate

6. Present design progress in written and oral format
Audience: Undergraduate

7. Defend design decisions with engineering calculations
Audience: Undergraduate

M E 361 – THERMODYNAMICS
3 credits.

First and second laws of thermodynamics; thermodynamic properties of gases, vapors, and gas-vapor mixtures; energy-systems analysis including power cycles, refrigeration cycles and air-conditioning processes. Introduction to thermodynamics of reacting mixtures.
Requisites: (CHEM 103 or 109) and (E M A 201, PHYSICS 201, 207, or 247), or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Summer 2025
Learning Outcomes: 1. Define both open and closed systems using a sketch
Audience: Undergraduate

2. Apply the first law to properly analyze open steady flow systems and closed systems
Audience: Undergraduate

3. Apply the second law to properly analyze open steady flow systems and closed systems
Audience: Undergraduate

4. Calculate property changes for ideal gases, incompressible substances, and real substances such as water
Audience: Undergraduate

5. Calculate First and Second Law efficiencies of engineering devices
Audience: Undergraduate

M E 363 – FLUID DYNAMICS
3 credits.

Laws of mechanics and thermodynamics applied to fluids at rest and in motion; potential flow; dimensional analysis; viscous flow; pipe flow; boundary-layer theory; compressible flow.
Requisites: M E 361 and (MATH 319, 320 or 375), or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Apply control volume analysis to solve fluid mechanics problems, for fluids at rest and in movement
Audience: Undergraduate

2. Simplify the equations of fluid mechanics to solve realistic engineering problems involving fluids by making appropriate assumptions
Audience: Undergraduate

3. Calculate losses in piping systems and other internal flows using dimensionless correlations
Audience: Undergraduate

4. Calculate forces created by external flow on a solid immersed in a fluid using dimensionless correlations
Audience: Undergraduate

M E 364 – ELEMENTARY HEAT TRANSFER
3 credits.

Fundamental concepts of conduction, convection, radiation. Heat-exchanger principles.
Requisites: M E 361 and (M E 363 or concurrent enrollment), or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Summer 2025
Learning Outcomes: 1. Predict the rate of heat transfer for steady state situations involving conduction, convection, and radiation
Audience: Undergraduate

2. Develop numerical models of 0-D, 1-D, and 2-D transient temperature distributions
Audience: Undergraduate

3. Develop computer models of radiation situations involving multiple grey surfaces
Audience: Undergraduate

4. Simulate and optimize heat exchangers for a variety of applications
Audience: Undergraduate

5. Qualitatively predict the velocity and temperature distribution associated with boundary layers in convection problems
Audience: Undergraduate

M E 368 – ENGINEERING MEASUREMENTS AND INSTRUMENTATION
4 credits.

Theory of modern instrumentation, the design and execution of experiments and the analysis of experimental data. Laboratory provides direct experience with concepts in the context of experimental design for hypothesis testing, for product evaluation and for control system design.
Requisites: (M E 306 or E M A 303), M E 361, 340, and (E C E 376, 230, or M E 376)
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Use common sensors such as thermocouples, thermistors, microphones and strain gauges to make engineering measurements
Audience: Undergraduate

2. Set up a digital data acquisition system to record, analyze and effectively display experimental data
Audience: Undergraduate

3. Calculate the uncertainty of a measurement and take action to reduce uncertainty through calibration and noise reduction
Audience: Undergraduate

4. Analyze an experiment and the results; troubleshoot any errors or deviations from expected theoretical values
Audience: Undergraduate

5. Analyze and interpret data in the frequency domain
Audience: Undergraduate

M E 370 – ENERGY SYSTEMS LABORATORY
3 credits.

Experimental evaluation and analysis of performance of various energy conversion systems such as turbines, compressors, refrigerators, fans, and internal combustion engines.
Requisites: M E 363 and (M E 364 or concurrent enrollment) and (M E 368 or concurrent enrollment)
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Characterize the performance parameters for common energy systems
Audience: Undergraduate

2. Safely measure the operation of energy system equipment
Audience: Undergraduate

3. Utilize software tools to analyze the data from the operation of energy system equipment
Audience: Undergraduate

4. Work cooperatively in a team configuration
Audience: Undergraduate

5. Communicate findings from energy system experiments in written, oral, and discussion formats
Audience: Undergraduate

M E 376 – INTRODUCTION TO MECHATRONICS
4 credits.

Fundamentals of DC and AC circuit analysis and design, stressing tools needed to understand circuits typically used in instrumentation and control of physical systems (sensors/actuators); an introduction to the design of active and passive linear circuits for buffering and filtering signals; an introduction to digital circuits, Boolean logic, programming, especially as needed for computer interface operations in mechanical engineering applications (example: embedded microcontrollers). Laboratory exercises.
Requisites: (M E 340 or concurrent enrollment), (MATH 320, 319, or 376), and (PHYSICS 202, 208, or 248), or graduate/professional standing
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Describe and mathematically represent circuit element properties and their analogies to mechanical systems
Audience: Undergraduate

2. Apply Kirchoff's and Ohm's laws to design and analyze AC and DC circuits
Audience: Undergraduate

3. Design and apply active and passive AC and DC circuits for instrumentation or control systems
Audience: Undergraduate

4. Design and analyze signal conditioning circuits utilized in instrumentation or control systems
Audience: Undergraduate

5. Write software to configure hardware, drive state machines, and control algorithms
Audience: Undergraduate

6. Utilize digital logic, computer interfaces, sensors, actuators, and programming approaches to solve mechanical engineering problems
Audience: Undergraduate

7. Communicate with experts in the various disciplines associated with instrumentation of and computer control of machines and processes
Audience: Undergraduate

M E/B M E 414 – ORTHOPAEDIC BIOMECHANICS - DESIGN OF ORTHOPAEDIC IMPLANTS
3 credits.

Apply the design process for orthopaedic implants (total joint replacements). Topics include: library skills; joint anatomy; tissue properties; surgical approach; joint loading; implants materials; preclinical testing and analysis.
Requisites: Senior standing and M E 342, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Apply engineering mechanics (statics, dynamics, mechanics of materials) to analyze human joints
Audience: Both Grad & Undergrad

2. Describe sources and implications of patient-to-patient variability in functional anatomy, biomechanics, and disease states
Audience: Both Grad & Undergrad

3. Synthesize knowledge about functional anatomy, biomechanics, and disease states to define clinical needs and design inputs
Audience: Both Grad & Undergrad

4. Justify design decisions and testing plans based on rigorous engineering calculations through both written and oral communication
Audience: Both Grad & Undergrad

5. Formulate rigorous testing plans for design and device verification and validation based on established standards and/or guidance documents
Audience: Both Grad & Undergrad

6. Analyze interactions between multiple sources of variability
Audience: Graduate

M E/B M E 415 – BIOMECHANICS OF HUMAN MOVEMENT
3 credits.

An overview of experimental and modeling techniques used to study human movement. Specific topics will include locomotion, motion capture systems, force plates, muscle mechanics, musculoskeletal modeling, three dimensional kinematics, inverse dynamics, forward dynamic simulation and imaging based biomechanics. Homework and laboratory activities emphasize applications of movement biomechanics in orthopedics and rehabilitation.
Requisites: B M E 315 and M E 340, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Identify and describe fundamental concepts and methods in movement biomechanics
Audience: Both Grad & Undergrad

2. Apply fundamental concepts and methods in biomechanics to acquire experience and gain confidence using engineering tools to study movement
Audience: Both Grad & Undergrad

3. Establish a framework for self-teaching and research through open-ended laboratory assignments and a research project
Audience: Both Grad & Undergrad

4. Constructively review and provide feedback on written research proposals related to movement biomechanics
Audience: Graduate

M E 417 – TRANSPORT PHENOMENA IN POLYMER PROCESSING
3 credits.

Description of the physical, thermal, mechanical, and rheological properties of polymeric materials relevant to their processing behavior. Review of the basic transport phenomena equations: mass, momentum, and energy. Analysis of various processing operations for the manufacture of polymeric articles, with particular emphasis on: extrusion, injection molding, blow molding, thermoforming, compression molding and additive manufacturing. Discussion of plastics recycling and environmental issues.
Requisites: Senior standing or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Summer 2025
Learning Outcomes: 1. Identify, formulate and solve problems related to the properties of polymeric material and how these properties are impacted by processing
Audience: Both Grad & Undergrad

2. Apply differential equations to transport phenomena
Audience: Both Grad & Undergrad

3. Demonstrate their understanding of various processing techniques including extrusion, injection molding, blow molding, thermoforming, compression molding, and additive manufacturing
Audience: Both Grad & Undergrad

4. Develop solutions to differential equations for transport problems that arise from polymer manufacturing processes
Audience: Graduate

M E 418 – ENGINEERING DESIGN WITH POLYMERS
3 credits.

Implications for plastics part design of polymer classification, structure, melt rheology, mixing, polymer blends, anisotropy, solidification, mechanical behavior, failure. Plastics design for electrical, optical, acoustic and barrier properties.
Requisites: Senior standing or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Demonstrate an understanding of the basic polymer classifications
Audience: Both Grad & Undergrad

2. Apply knowledge of polymer classifications to part design
Audience: Both Grad & Undergrad

3. Utilize the techniques, skills and modern tools necessary for polymer part design
Audience: Both Grad & Undergrad

4. Synthesize knowledge about polymers and use insight and creativity to better understand and improve polymer parts
Audience: Graduate

M E 419 – FUNDAMENTALS OF INJECTION MOLDING
3 credits.

All major aspects of injection molding with emphases on design, processing, process physics, computer-aided engineering (CAE), troubleshooting, and advanced molding processes. Field trip, video presentation, case studies, term project with oral presentation, and hands-on sessions using commercial CAE simulation software.
Requisites: Senior standing, member of Engineering Guest Students, or declared in Capstone Certificate in Polymer Processing and Manufacturing
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Apply techniques and decision making tools for increased quality, product safety and reliability, and productivity
Audience: Undergraduate

2. Apply quality improvement methods that lead to better quality, decreased cost, reduced cycle time, and sustainability
Audience: Undergraduate

3. Demonstrate the use of concepts and practices of processing, materials, designs, general skill sets like control, computer-aided engineering (CAE), and optimization, and special topics that includes emerging and competing technologies and advanced molding processes
Audience: Undergraduate

4. Synthesize understanding in all aspects of injection molding and related processes, to take on tasks and challenges related to material processing
Audience: Undergraduate

5. Apply process insights and develop logical thinking, problem-solving skills, life-long learning attitude, independent research capabilities, as well as presentation and communication skills
Audience: Undergraduate

M E/STAT 424 – STATISTICAL EXPERIMENTAL DESIGN
3 credits.

Introduction to statistical design and analysis of experiments. Topics include: principles of randomization, blocking and replication, randomized blocking designs, Latin square designs, full factorial and fractional factorial designs and response surface methodology. Substantial focus will be devoted to engineering applications.
Requisites: STAT 240, 301, 302, 312, 324, 371, or MATH/STAT 310
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Describe key concepts in the design and analysis of experiments.
Audience: Undergraduate

2. Generate experimental designs and apply appropriate analysis techniques.
Audience: Undergraduate

3. Compare different experimental design and analysis methods in various scenarios.
Audience: Undergraduate

4. Apply experimental design and analysis methods in real-world projects.
Audience: Undergraduate

5. Implement experimental design and analysis methods in statistical software like R.
Audience: Undergraduate

M E 429 – METAL CUTTING
3 credits.

Theory and applications of metal cutting; basic principles; significant features of current research. Chip formation mechanics, three-dimensional machining operations, tool life and machinability, economics of metal removal, and precision engineering.
Requisites: Senior standing and declared in Biomed, Biological Sys, Chemical, Civil, Computer, Electrical, Geological, Industrial, Mechanical or Nuclear Egr, Materials Sci & Egr, Egr Physics, Egr Mechanics, grad/professional standing or member of Egr Guest Students
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Apply mechanics of materials, tribology, dynamics, conservation of mass, and heat transfer fundamentals to analyze chip formation, cutting temperatures, burr formation, chatter, and tool wear
Audience: Undergraduate

2. Recognize the interrelationships between process parameters and cutting performance
Audience: Undergraduate

3. Make a metal part on a CNC machine using G-code
Audience: Undergraduate

4. Present examples of how manufacturing impacts society, the economy, and the environment
Audience: Undergraduate

5. Apply professional codes to analyze problems in manufacturing ethics and arrive at defensible actions
Audience: Undergraduate

M E 437 – ADVANCED MATERIALS SELECTION
3 credits.

A structured approach is developed to address the complex problem of materials selection in design where multiple constraints and conflicting objectives need to be considered. Topics include: introductory fracture mechanics; corrosion and corrosion mitigation; effects of manufacturing processes and process selection; property development in metals, ceramics, polymers and composites; and material analysis techniques.
Requisites: (M S & E 350 and M E 310), M E 313, M S & E 332, graduate/professional standing, or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Identify designs at risk of brittle fracture
Audience: Undergraduate

2. Apply a basic fracture mechanics approach to minimize chance of part failure
Audience: Undergraduate

3. Apply corrosion mitigation techniques to material selection and design problems
Audience: Undergraduate

4. Apply a systematic process to materials selection
Audience: Undergraduate

5. Interpret microstructure of metallic alloys and predict material property development
Audience: Undergraduate

M E/E C E 439 – INTRODUCTION TO ROBOTICS
3 credits.

Hands-on introduction to key concepts and tools underpinning robotic systems in use and development today. Intended to give students the tools to understand robotic systems, to explore robotics for their own purposes, and to pursue advanced study in the field. Students are expected to have familiarity with a high level programming language such as Python (recommended), MATLAB, Java or Julia.
Requisites: Senior standing or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Summer 2025
Learning Outcomes: 1. Predict and control the behavior of common mechatronic actuators
Audience: Undergraduate

2. Predict and interpret the response of common sensors in relation to their environment
Audience: Undergraduate

3. Apply standard algorithms to predict and control the behavior of robotic manipulators
Audience: Undergraduate

4. Interpret the operation of a robot control system and add new functionality to it
Audience: Undergraduate

5. Specify a simple task for a robot, and implement sensors, actuators and a control system to accomplish it
Audience: Undergraduate

6. Analyze the ethical challenges presented by specific robotic applications
Audience: Undergraduate

M E 440 – INTERMEDIATE VIBRATIONS
3 credits.

Harmonic motion; natural frequencies and vibration of damped and undamped single and multi-degree of freedom systems; modal analysis; influence coefficients; lumped-mass modeling; dynamic load factors; Rayleigh's method; flow-induced vibrations; shaft whirl; balancing; vibration absorbers and tuned mass dampers; finite element modeling.
Requisites: (M E 306 or E M A 303) and (M E 340 or E M A/M E 540), or graduate/professional standing, or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Summer 2025
Learning Outcomes: 1. Derive the equations of motion of single and multi-degree of freedom systems
Audience: Undergraduate

2. Determine the natural frequencies and mode shapes of single and multi-degree of freedom systems
Audience: Undergraduate

3. Evaluate the dynamic response of single and multi-degree of freedom systems under impulsive, harmonic and periodic loading
Audience: Undergraduate

4. Apply modal analysis and orthogonality conditions to establish the dynamic characteristics of multi-degree of freedom systems
Audience: Undergraduate

5. Generate finite element models of discrete systems to simulate the dynamic response to initial conditions and external excitations
Audience: Undergraduate

M E/E C E 441 – KINEMATICS, DYNAMICS, AND CONTROL OF ROBOTIC MANIPULATORS
3 credits.

Robotics analysis and design, focusing on the analytical fundamentals specific to robotic manipulators. Serial chain robotic manipulator forward and inverse kinematics, differential kinematics, dynamics, trajectory generation, and controls. Builds on knowledge of high-level computational programming language such as Matlab.
Requisites: M E 340 and (MATH 320, 340, 341, or 375), graduate/professional standing, or member of Engineering Guest Students. Not open to students with credit for E C E 739 prior to fall 2024.
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Analyze and design serial chain robotic manipulator kinematics
Audience: Both Grad & Undergrad

2. Simulate the dynamic motion of serial chain robotic manipulators
Audience: Both Grad & Undergrad

3. Form the equations of motion for robotic manipulators
Audience: Both Grad & Undergrad

4. Use feedback control for tracking and regulation of robotic manipulators for position, force, and hybrid control
Audience: Both Grad & Undergrad

5. Use trajectory generation methods to design robotic manipulator motion and force trajectories
Audience: Both Grad & Undergrad

6. Analyze the kinematics and controls of more complex serial chain manipulators
Audience: Graduate

7. Design the kinematics of serial chain manipulators using kinematic and dynamics analysis methods
Audience: Graduate

M E 444 – DESIGN PROBLEMS IN ELASTICITY
3 credits.

Analysis of elastic systems by strain-energy techniques. Determination of stresses and deflections in statically indeterminate structures encountered in design. Resilience in springs.
Requisites: M E 306, E M A 303, graduate/professional standing, or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Spring 2024
Learning Outcomes: 1. Solve for the octahedral stress, stress invariants, principal stresses and direction cosines of the principal stresses for a state of stress involving 3 orthogonal normal stresses and 3 orthogonal shear stresses
Audience: Undergraduate

2. Calculate strain energy density and strain energy for normal stresses from axial and bending loads and for shear stresses from torque loads within the elastic range
Audience: Undergraduate

3. Apply energy methods to linear elastic structural mechanics problems including the Principle of Virtual work, Reciprocity Theorem, Unit Load Method, Castigliano's Theorem, Stationary Potential Energy and the Rayleigh-Ritz Method
Audience: Undergraduate

4. Verify compatibility and equilibrium of displacement fields for plane elasticity problems and solve for the corresponding stresses and/or strains

Audience: Undergraduate

5. Analyze the stresses, strains and displacements caused by thermal, pressurization and rotational loading of axisymmetric plane elasticity problems (hollow and solid disks)
Audience: Undergraduate

M E 445 – MECHATRONICS IN CONTROL & PRODUCT REALIZATION
3 credits.

Fundamentals of electromechanical control systems with a focus on subsystem design and their impacts at the system level. Integration of microcontrollers into products for control and/or instrumentation. Creation of intelligent interfaces between motors and sensors. C programming. Control computer system architecture Software and hardware principles for computer control.
Requisites: M E 376, E C E 376, 230, or (B M E 201 and B M E 310), graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2022
Learning Outcomes: 1. Demonstrate understanding of the fundamentals of electromechanical control systems including motor and sensor interfaces and computer system architecture
Audience: Both Grad & Undergrad

2. Apply knowledge of microcontrollers embedded in products in order to create intelligent interfaces
Audience: Both Grad & Undergrad

3. Apply knowledge of software and hardware principles for computer control in order to develop and demonstrate control systems in lab
Audience: Both Grad & Undergrad

4. Practice good coding techniques in C and develop skills with troubleshooting both hardware and software
Audience: Both Grad & Undergrad

5. Demonstrate understanding of more advanced issues related to system level design issues
Audience: Graduate

M E 446 – INTRODUCTION TO FEEDBACK CONTROL
3 credits.

Overview of linear feedback control analysis and design techniques for mechanical systems. Modeling of linear dynamic mechanical systems (review), derivation of their defining differential equations, and analysis of their response using both transient and frequency response techniques; Analysis and design of feedback control of mechanical systems using classical control transform techniques such as root locus and frequency response; Analysis of system robustness through evaluation of phase and gain margins and the Nyquist stability criterion. Design of feedback controllers for mechanical systems using frequency domain loop-shaping methods. Design domains, including mechanical, thermal, and fluid feedback control systems. Effects of non-ideal system characteristics commonly encountered in mechanical systems, such as compliance, delay, and actuator and sensor saturation. Builds on knowledge of high-level computational programming language such as Matlab or Simulink.
Requisites: (M E 340 or E M A 545) and (MATH 319 or 320), graduate/professional standing, member of Engineering Guest Students, or declared in Capstone Certificate in Power Conversion and Control. Not open to students with credit for M E 346.
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Summer 2025
Learning Outcomes: 1. Solve for the time-domain response of differential equations associated with physical dynamic systems
Audience: Both Grad & Undergrad

2. Simulate the time-domain response and frequency-response of physical dynamic systems using computer analysis and design tools such as Matlab
Audience: Both Grad & Undergrad

3. Analyze and design PID feedback controllers for simple first and second order physical systems
Audience: Both Grad & Undergrad

4. Analyze the stability of linear systems using the Nyquist stability criteria and its equivalent frequency domain representation
Audience: Both Grad & Undergrad

5. Analyze and design modern feedback control systems using frequency domain analysis and design techniques, including the use of frequency loop shaping to achieve desired transient and steady-state design specifications
Audience: Both Grad & Undergrad

6. Analyze and design complex linear feedback controllers for a range of mechanical dynamic systems, including systems with non-ideal characteristics such as flexible modes, time delay, actuator saturation, and unstable open-loop systems
Audience: Graduate

M E 447 – COMPUTER CONTROL OF MACHINES AND PROCESSES
3 credits.

Discrete control theory reduced to engineering practice through a comprehensive study of discrete system modeling, system identification and digital controller design. Selected industrial processes and machines utilized as subjects on which computer control is to be implemented. Focus: computer control economics and planning as well as the control theory and programming.
Requisites: M E 340, 346, or 446, graduate/professional standing, or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Spring 2025

M E 448 – MECHANICAL SYSTEMS ANALYSIS
3 credits.

Integrated treatment of mathematical modeling and analysis of mechanical systems. Modeling of linear and nonlinear systems and their performance under transient, periodic and random loads.
Requisites: Senior standing and declared in Biomed, Biological Sys, Chemical, Civil, Computer, Electrical, Geological, Industrial, Mechanical or Nuclear Egr, Materials Sci & Egr, Egr Physics, Egr Mechanics, Applied Math, Egr and Physics, grad/prof or EGRG
Repeatable for Credit: No
Last Taught: Fall 2020
Learning Outcomes: 1. Analyze ideal mechanisms and trusses systems
Audience: Undergraduate

2. Apply Bayes theorem of probability
Audience: Undergraduate

3. Carry out statistical analysis of mechanisms and truss systems
Audience: Undergraduate

4. Use MATLAB toolbox for Monte Carlo analysis
Audience: Undergraduate

5. Quantify the reliability of designs through first-order methods
Audience: Undergraduate

6. Quantify the reliability of designs through second-order methods
Audience: Undergraduate

M E 449 – REDESIGN AND PROTOTYPE FABRICATION
3 credits.

Principles of design, manufacturing, and prototype evaluation. A semester long project provides the opportunity to redesign of a thermo-mechanical device (Stirling Engine) using knowledge/skills acquired both through this course and previous course offerings in thermal sciences, mechanics and dynamics, manufacturing, and design. Instruction and hands-on experience using the manufacturing tools/processes available in the CoE. Design, dimensioning and tolerancing, manufacturing, and quantitative analysis are all covered in a structured semester project.
Requisites: Senior standing and (M E 306 or E M A 303), (M E 311 or 313 or concurrent enrollment), and M E 331, or graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Demonstrate understanding of design, manufacturing and prototype evaluation
Audience: Both Grad & Undergrad

2. Redesign a thermo-mechanical device (Stirling Engine) using knowledge/skills in thermal sciences, mechanics and dynamics, manufacturing, and design
Audience: Both Grad & Undergrad

3. Utilize the techniques, skills and modern tools necessary for manufacturing small prototypes
Audience: Both Grad & Undergrad

4. Fabricate a Stirling Engine and test this prototype
Audience: Both Grad & Undergrad

5. Apply knowledge of design, dimensioning, and tolerancing
Audience: Both Grad & Undergrad

6. Write clear and concise technical reports and research articles
Audience: Graduate

M E 451 – KINEMATICS AND DYNAMICS OF MACHINE SYSTEMS
3 credits.

Graphical, analytical, and computer methods for the kinematic and dynamic analysis of mechanical linkages, mechanisms, and geared and cam systems.
Requisites: M E 240, E M A 202, PHYSICS 201, 207, 247, graduate/professional standing, or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Spring 2023
Learning Outcomes: 1. Formulate the equations of motion for mechanisms that display 3D motion
Audience: Undergraduate

2. Describe the concept of joints between bodies that make up a mechanism
Audience: Undergraduate

3. Derive the kinematics equations
Audience: Undergraduate

4. Derive the dynamics equations of motion
Audience: Undergraduate

5. Solve differential equations that govern the evolution of a system
Audience: Undergraduate

6. Use numerical algorithms to solve the differential algebraic equations associated with the time evolution of a multi-body mechanical system
Audience: Undergraduate

M E 455 – MICROROBOTICS
3 credits.

Microrobotics is an emerging interdisciplinary field at the intersection of robotics, microtechnology, materials science, and bioengineering gearing towards key applications in healthcare and biomedical sciences. Design, fabrication, powering/actuation, locomotion, localization, swarm operation and biomedical applications of microrobots.
Requisites: M E 342 and (M E 376 or B M E 310), or graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Learning Outcomes: 1. Design and develop microrobots for biomedical applications
Audience: Both Grad & Undergrad

2. Employ scaling laws and micromechanics for microrobot design
Audience: Both Grad & Undergrad

3. Describe approaches to microrobot fabrication
Audience: Both Grad & Undergrad

4. Design and evaluate microrobot powering/actuation and locomotion strategies
Audience: Both Grad & Undergrad

5. Integrate localization and swarm operation techniques for microrobot control
Audience: Graduate

M E 458 – INTRODUCTION TO FEEDBACK CONTROL OF AUTONOMOUS SYSTEMS
3 credits.

Feedback control theory fundamentals; numerical optimal control algorithms underpinning autonomous systems; quadcopter kinematics dynamics; quadcopter control and trajectory planning; hands-on labs on a nano quadcopter platform.
Requisites: M E 446, E M A 545, E C E 332, or 334, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Learning Outcomes: 1. Express a dynamic system into its state space form and determine its linearized model around a given operating point
Audience: Both Grad & Undergrad

2. Use Lyapunov direct and indirect methods to determine the stability of nonlinear systems
Audience: Both Grad & Undergrad

3. Explain and assess controllability, observability, and stability of linear systems
Audience: Both Grad & Undergrad

4. Solve general optimal control problems using off-the-shelf numerical software
Audience: Both Grad & Undergrad

5. Solve linear quadratic problems using linear quadratic regulator
Audience: Both Grad & Undergrad

6. Apply differential flatness for quadcopter trajectory generation, and design linear tracking controllers for quadcopters
Audience: Both Grad & Undergrad

7. Apply the maximum principle to find the optimal solution of an unconstrained optimal control problem
Audience: Graduate

M E 459 – COMPUTING CONCEPTS FOR APPLICATIONS IN ENGINEERING
3 credits.

An overview of computing concepts that support modeling and simulation in engineering applications. Learn the basics of computer architecture, software development and the interplay between software and hardware components.
Requisites: COMP SCI 200, 220, 300, 301, 302, 320, or placement into COMP SCI 300, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2023
Learning Outcomes: 1. Use Python and C to generate programs that can effectively perform data processing tasks on modern CPU architectures
Audience: Both Grad & Undergrad

2. Describe how a central processing unit (CPU) functions
Audience: Both Grad & Undergrad

3. Describe the roles of memory hierarchy and virtual memory in computing
Audience: Both Grad & Undergrad

4. Identify the role of the operating system in computing
Audience: Both Grad & Undergrad

5. Describe the implications of representing and carrying out operations with numbers using a finite number of bits
Audience: Both Grad & Undergrad

6. Identify computational bottlenecks associated with suboptimal memory accesses and/or poor instruction pipelining
Audience: Graduate

M E 460 – APPLIED THERMAL / STRUCTURAL FINITE ELEMENT ANALYSIS
3 credits.

The course is designed for undergraduate students with no finite element (FE) analysis experience or knowledge. By the end of the semester the student will be able to simulate 1D, 2D and 3D structural and thermal systems, including both the static and transient response, using a common, commercially available FE software package. Analyses will be performed using both GUI and APDL. The emphasis of the course is on becoming proficient with the software and capable of operating an FE package at a high level, including benchmarking and verifying the FE model using simple analytical checks. An additional emphasis of the course is on understanding the impact of the temperature distribution in an object on the stress field through thermal expansion.
Requisites: M E 306 or E M A 303, or graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Generate an ANSYS FE model to assess the steady-state / static structural or thermal response of a 1-D, 2-D or 3-D component or structure
Audience: Both Grad & Undergrad

2. Determine an appropriate element type, specify the material properties and apply loads, boundary conditions and constraints for both thermal and structural ANSYS simulations
Audience: Both Grad & Undergrad

3. Apply time dependent loads and boundary conditions to perform both thermal and structural transient analyses
Audience: Both Grad & Undergrad

4. Postprocess a FE model solution in ANSYS to possibly determine quantities such as temperature, stress, displacements and natural frequencies (and associated mode shapes)
Audience: Both Grad & Undergrad

5. Generate an ANSYS FE model to assess the transient structural or thermal response of a 1-D, 2-D or 3-D component or structure
Audience: Graduate

M E 461 – THERMAL SYSTEMS MODELING
3 credits.

Analysis and design of engineering systems involving applications of thermodynamics, economics, heat transfer, and fluid flow.
Requisites: M E 364 or concurrent enrollment, or graduate/professional standing, or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Explain the importance of advanced thermodynamics topics and novel cycles
Audience: Undergraduate

2. Apply the first and second laws of thermodynamics to complex thermal systems and system components
Audience: Undergraduate

3. Integrate rate mechanisms (i.e., heat transfer and fluid dynamics), economics, and optimization into the design and analysis of thermal systems
Audience: Undergraduate

4. Communicate the inherent uncertainty in the design and analysis of thermal systems
Audience: Undergraduate

5. Analyze yearly thermal system performance driven by weather variations
Audience: Undergraduate

6. Use a computer effectively to solve engineering problems
Audience: Undergraduate

7. Work in teams to solve open-ended design problems pertaining to thermal systems
Audience: Undergraduate

M E/M S & E 462 – WELDING METALLURGY
3 credits.

Metallurgical principles applied to welding; mechanisms of strengthening, phase equilibria, and microstructure of the weld zone. Modern processes including laser and electron beam welding.
Requisites: None
Repeatable for Credit: No
Last Taught: Fall 2023
Learning Outcomes: 1. Identify the specific types of fusion and solid-state processes for welding specific metals/alloys of specific geometries and joints
Audience: Undergraduate

2. Relate principles of heat transfer, fluid flow, mass transfer, chemical reactions, and phase transformations during welding to the development of microstructure, properties, and defects of welds
Audience: Undergraduate

3. Identify the causes and remedies of various defects in welds, such as gas porosity, loss of strength, loss of toughness, cracking, and corrosion
Audience: Undergraduate

4. Identify processes for welding dissimilar materials, such as aluminum alloys to steels, aluminum alloys to copper
Audience: Undergraduate

M E 468 – COMPUTER MODELING AND SIMULATION OF AUTONOMOUS VEHICLES AND ROBOTS
3 credits.

Introduction to the Robot Operating System (ROS). Concepts of vehicle dynamics modeling and simulation, with focus on tire, suspension, steering system, and powertrain modeling. Simulation of sensors (camera, lidar, radar, GPS, IMU). Terramechanics modeling for mobility on deformable terrains. Introduction to the autonomy stack (sensing, perception, planning, and control). Elements of artificial intelligence in autonomy. Elements of verification and validation.
Requisites: M E 459 and (COMP SCI 200, 220, 300, 301, 302, 320, or placement into COMP SCI 300), graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2022
Learning Outcomes: 1. Use computer simulation in the process of designing and analyzing new autonomous vehicles and robots
Audience: Both Grad & Undergrad

2. Create a ROS (Robot Operating System) infrastructure for a simple robot or small scale autonomous vehicle
Audience: Both Grad & Undergrad

3. Create a ROS infrastructure used in conjunction with an autonomy stack to simulate the behavior of a robot or autonomous vehicle
Audience: Both Grad & Undergrad

4. Identify the main modeling techniques used to approximate through computer simulation the real world dynamics/behavior of autonomous vehicles and robots
Audience: Both Grad & Undergrad

5. Gain a panoramic image of modeling and simulation requirements associated with the multi-disciplinary task of designing autonomous vehicles and robots
Audience: Undergraduate

6. Integrate the activities of designing, implementing, building, validating and positioning for release software for modeling and simulation of autonomous vehicles and robots
Audience: Graduate

7. Propose and evaluate alternate or novel methods to achieve modeling and simulation objectives, defend opinions
Audience: Graduate

M E 469 – INTERNAL COMBUSTION ENGINES
3 credits.

Fundamental principles of engine operation and application including cycle analysis, gas analysis, effect of operating conditions and engine design on air pollution.
Requisites: M E 361, or graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Identify the basic characteristics of internal combustion engine operation
Audience: Both Grad & Undergrad

2. Use thermodynamic principles to analyze various types of internal combustion engines
Audience: Both Grad & Undergrad

3. Recognize, describe, predict, and analyze internal combustion engines subject to modifications and improvements that are related to the state of the art
Audience: Both Grad & Undergrad

4. Communicate effectively through written reports related to ongoing timely research in the area of internal combustion engines
Audience: Graduate

M E 471 – GAS TURBINE AND JET PROPULSION
3 credits.

Principles of thermodynamics and fluid dynamics utilized in the analysis and design of gas-turbine cycles, components and systems for stationary, automotive and aircraft applications.
Requisites: M E 364, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Explain the importance of advanced thermodynamics topics and novel gas turbine cycles that are not covered (or too quickly covered) in undergraduate thermodynamics courses
Audience: Both Grad & Undergrad

2. Design and analyze various gas turbine components
Audience: Both Grad & Undergrad

3. Apply advanced gas turbine design concepts
Audience: Both Grad & Undergrad

4. Use a computer effectively to solve engineering problems
Audience: Both Grad & Undergrad

5. Carry out optimization of systems incorporating economic and other technical considerations
Audience: Graduate

M E 472 – ENERGY, SUSTAINABILITY, AND TECHNOLOGY
3 credits.

Thermodynamic analysis of energy conversion systems with emphasis on efficiency and greenhouse gas emissions; basic economic analysis of energy systems; radiative energy exchange with participating atmosphere; global energy balance; electricity production and transportation sustainability.
Requisites: M E 361 and (COMP SCI 200, 220, 300, 301, 310, or placement into COMP SCI 300), or graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Evaluate the sustainability of energy conversion systems
Audience: Both Grad & Undergrad

2. Calculate changes in radiation trapping in the atmosphere due to different compounds
Audience: Both Grad & Undergrad

3. Apply simple economic models to define levelized cost of electricity production
Audience: Both Grad & Undergrad

4. Develop a simple model to predict carbon dioxide concentration in atmosphere
Audience: Both Grad & Undergrad

5. Analyze transportation sustainability for light- and heavy-duty applications
Audience: Both Grad & Undergrad

6. Model and evaluate the sustainability of domestic heating requirements

Audience: Both Grad & Undergrad

7. Coordinate models of energy conversion and greenhouse gas emissions

Audience: Graduate

M E/BSE 474 – FLUID POWER
3 credits.

Engineering principles of design and analysis of fluid power systems and fluid power components. Topics include hydraulic fluid properties, fluid flow and, positive displacement pumps, valves for pressure, flow, and directional control, linear and rotary actuators, accumulators, pressure compensation, load sensing, energy management and system efficiency.
Requisites: M E 363, CIV ENGR 310, CBE 320, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Analyze various positive displacement pumps for flow, pressure, power, and efficiency
Audience: Both Grad & Undergrad

2. Determine flow and pressure drop characteristics of spool-type and poppet-type proportional, on-off, and servovalves
Audience: Both Grad & Undergrad

3. Construct hydraulic system schematics and select components from a functional system description
Audience: Both Grad & Undergrad

4. Determine efficiency and design improvements for mobile and industrial hydraulic systems
Audience: Both Grad & Undergrad

5. Develop mathematical models of hydraulic system/components and solve using numerical techniques
Audience: Graduate

M E/BSE 475 – ENGINEERING PRINCIPLES OF AGRICULTURAL MACHINERY
3 credits.

Engineering design principles of machines for the production, processing and handling of crops for food, fuel, bio-mass and fiber. Environmental and biological factors that influence machine design and operation. Economic and capacity analysis of machines and systems.
Requisites: Declared in Biological Systems Engineering or Mechanical Engineering and (M E 240, E M A 202, PHYSICS 201, 207, or 247), graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Identify and describe key operating and design principles, concepts, and methods related to agricultural field machinery
Audience: Both Grad & Undergrad

2. Calculate relevant quantities regarding the design and engineering of agricultural field machinery
Audience: Both Grad & Undergrad

3. Critically review results of engineering calculations to ensure answers are realistic
Audience: Both Grad & Undergrad

4. Choose, synthesize and effectively utilize appropriate ASABE engineering standards, methods, and concepts regarding agricultural field machinery
Audience: Both Grad & Undergrad

5. Hone skills in teamwork, oral and written communication, and problem solving
Audience: Both Grad & Undergrad

6. Critically review emerging technology and apply relevant concepts to current issues with agricultural field machinery
Audience: Both Grad & Undergrad

7. Demonstrate an ability to formulate, analyze, and independently solve advanced engineering problems
Audience: Graduate

M E/BSE 476 – ENGINEERING PRINCIPLES OF OFF-ROAD VEHICLES
3 credits.

Engineering design principles of heavy-duty vehicles intended for off-road use: fuels, engine cycles, engine principles and construction, clutches, mechanical and hydrostatic transmissions, final drives, traction systems, traction modeling, dynamic behavior, suspension systems and braking.
Requisites: (M E 361 or concurrent enrollment), (M E 240, E M A 202, PHYSICS 201, 207, or 247), and declared in Biological Systems Engineering or Mechanical Engineering or graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Summer 2025
Learning Outcomes: 1. Identify, formulate, and solve engineering problems related to off-road vehicle dynamics and mobility
Audience: Both Grad & Undergrad

2. Glean relevant data from the engineering research literature and technical data sheets, and specify appropriate components and systems in the application of off-road vehicle design
Audience: Both Grad & Undergrad

3. Perform an experiment on off-road vehicle systems, analyze and interpret data, and use engineering judgment to draw conclusions
Audience: Both Grad & Undergrad

4. Apply knowledge gained in the course to evaluate off-road vehicle design alternatives
Audience: Both Grad & Undergrad

5. Critically review off-road vehicle research
Audience: Graduate

M E 489 – HONORS IN RESEARCH
1-3 credits.

Undergraduate honors research projects supervised by faculty members.
Requisites: Consent of instructor
Course Designation: Honors - Honors Only Courses (H)
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2025
Learning Outcomes: 1. Apply basic physical and mathematical principles to engineering research problems
Audience: Undergraduate

2. Apply basic mechanical engineering principles to engineering research problems
Audience: Undergraduate

3. Communicate technical concepts to a diverse audience via verbal or written media
Audience: Undergraduate

M E 491 – MECHANICAL ENGINEERING PROJECTS I
1-3 credits.

Individual lab projects under staff supervision.
Requisites: Consent of instructor
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2025
Learning Outcomes: 1. Apply basic physical and mathematical principles to engineering research problems
Audience: Undergraduate

2. Apply basic mechanical engineering principles to engineering research problems
Audience: Undergraduate

3. Communicate technical concepts to a diverse audience via verbal or written media
Audience: Undergraduate

M E 492 – MECHANICAL ENGINEERING PROJECTS II
1-3 credits.

Continuation of M E 491.
Requisites: Consent of instructor
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2025
Learning Outcomes: 1. Apply basic physical and mathematical principles to engineering research problems
Audience: Undergraduate

2. Apply basic mechanical engineering principles to engineering research problems
Audience: Undergraduate

3. Communicate technical concepts to a diverse audience via verbal or written media
Audience: Undergraduate

M E/B M E 505 – BIOFLUIDICS
3 credits.

Introduction to the physics of biological fluid flow with an emphasis on the cardiovascular system including blood rheology, pulsatile flow, wave travel, and topics relevant to blood flow measurement and biomedical device design.
Requisites: B M E 330, CBE 320, M E 363, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Explain the physical properties of a fluid and the consequence of such properties on fluid flow; compare and contrast non-Newtonian models for blood rheology
Audience: Both Grad & Undergrad

2. State the conservation principles of mass, linear momentum, and energy for fluid flow
Audience: Both Grad & Undergrad

3. Analyze systems using the conservation equations
Audience: Both Grad & Undergrad

4. Identify the relevant parameters that govern a fluid system and use dimensional analysis to identify the fundamental variables that define flow
Audience: Both Grad & Undergrad

5. Describe the flow dynamic metrics in different physiological or pathological conditions
Audience: Both Grad & Undergrad

6. Identify the role of other professionals in biofluid mechanics
Audience: Graduate

7. Foster skills to interact with clinical professionals
Audience: Graduate

M E/CIV ENGR/E M A 508 – COMPOSITE MATERIALS
3 credits.

Physical properties and mechanical behavior of polymer, metal, ceramic, cementitious, cellulosic and biological composite systems; micro- and macro-mechanics; lamination and strength analyses; static and transient loading; fabrication; recycling; design; analytical-experimental correlation; applications.
Requisites: (E M A 303 or M E 306), graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2024
Learning Outcomes: 1. List the different types of composite materials and describe their manufacturing processes
Audience: Both Grad & Undergrad

2. Describe the mechanical behavior of various composite materials under different types of loading conditions
Audience: Both Grad & Undergrad

3. Derive mathematical models and solve them for engineering stresses and deformations in a composite structure
Audience: Both Grad & Undergrad

4. Describe special theories for heterogeneous and non-isotropic materials and solve boundary value problems associated with composite structures
Audience: Both Grad & Undergrad

5. Use the knowledge acquired in this class to design and conduct a complex analysis, design, and/or experiment to address key challenges relevant to composite materials
Audience: Graduate

M E/I SY E 510 – FACILITIES PLANNING
3 credits.

Introduction to plant location theory and analysis of models of plant location; models for determining plant size and time phasing; line balancing models; techniques for investigating conveyor and other material handling problems; and models of plant layout.
Requisites: I SY E 315, (I SY E 323 or E C E/COMP SCI/I SY E 524) and I SY E/PSYCH 349, or graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Identify, formulate, and solve facilities layout problems by applying principles of engineering and mathematics
Audience: Both Grad & Undergrad

2. Apply engineering design to produce facilities design solutions that meet specified needs with consideration of productivity, safety, and economic factors
Audience: Both Grad & Undergrad

3. Utilize computer software to study and illustrate the operation of a manufacturing system
Audience: Both Grad & Undergrad

4. Collaborate with a team to develop solutions to engineering problems and communicate findings effectively
Audience: Both Grad & Undergrad

5. Demonstrate ability to lead a facilities planning project integrating quantitative techniques and management tools
Audience: Graduate

M E/I SY E 512 – INSPECTION, QUALITY CONTROL AND RELIABILITY
3 credits.

Inspection data for quality control; sampling plans for acceptance inspection; charts for process control. Introduction to reliability models and acceptance testing.
Requisites: (STAT/MATH 309, STAT 311, 224, 324, or STAT/MATH 431), graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Summer 2025
Learning Outcomes: 1. Apply statistical process control analysis for measuring and controlling quality
Audience: Undergraduate

2. Recognize, formulate, and analyze univariate continuous and discrete control charts
Audience: Undergraduate

3. Use Minitab to perform basic statistical process control analysis
Audience: Undergraduate

4. Communicate the results of the statistical process control analysis to management and other non-specialist users of engineering analyses
Audience: Undergraduate

5. Recognize, formulate, and analyze advanced continuous control charts
Audience: Graduate

6. Perform process capability and measurement system capability analysis

Audience: Graduate

M E 514 – POLYMER ADDITIVE MANUFACTURING
3 credits.

A quantitative and qualitative study of additive manufacturing processes. Emphasis on proper additive manufacturing technique selection for optimized final product design and properties, as well as presentation of emerging additive manufacturing techniques.
Requisites: Senior standing and (M E 310 or 313), graduate/professional standing, member of Engineering Guest Students, or declared in Capstone Certificate in Polymer Processing and Manufacturing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Summer 2025
Learning Outcomes: 1. Compare the different additive manufacturing (AM) techniques and identify their strengths and weaknesses
Audience: Both Grad & Undergrad

2. Identify the key components and underlying principles of AM processes
Audience: Both Grad & Undergrad

3. Identify the latest developments and critical challenges of AM
Audience: Both Grad & Undergrad

4. Evaluate literature and/or news articles to assess the potential and maturity level of AM applications or technologies
Audience: Both Grad & Undergrad

5. Use a 3D printer to produce a part from 3D model data
Audience: Both Grad & Undergrad

6. Select the appropriate AM technology for specific product requirements
Audience: Both Grad & Undergrad

7. Identify key principles of design for AM
Audience: Both Grad & Undergrad

8. Recite the latest developments as presented in the archival journals in the field, such as the Journal of Additive Manufacturing
Audience: Graduate

9. Explain the transport phenomena equations to model the underlying physics that control additive manufacturing techniques
Audience: Graduate

M E/B M E 516 – FINITE ELEMENTS FOR BIOLOGICAL AND OTHER SOFT MATERIALS
3 credits.

Finite element modeling of soft materials, with an emphasis on biological tissues. Basics of the finite element method, verification and validation methods, and selection of constitutive models. Emphasis on finite element modeling for materials that are generally nonlinear, and that generally undergo large deformation.
Requisites: (M E 306 or E M A 303), graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2024
Learning Outcomes: 1. Define the finite element method, explain its mathematical basis, and articulate alternatives
Audience: Both Grad & Undergrad

2. Justify the selection of a constitutive model for a particular modeling application
Audience: Both Grad & Undergrad

3. Design and complete validation and verification analyses
Audience: Both Grad & Undergrad

4. Build and analyze a finite element model, and present relevant results
Audience: Both Grad & Undergrad

5. Complete a term project using finite element analysis individually
Audience: Graduate

M E/N E 520 – TWO-PHASE FLOW AND HEAT TRANSFER
3 credits.

Two-phase flow and heat transfer in engineering systems. Pool boiling and flow boiling. Phenomenological modeling.
Requisites: M E 361 and (M E 364 or CBE 320), or graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2024

M E 529 – DESIGN & APPLICATIONS OF SMART MANUFACTURING PROCESSES
3 credits.

Introduction to smart manufacturing. Understand how a company can connect its operational technology systems (e.g., machine tools) to its information technology systems to improve operational efficiency. Covers terminology, sensors and data, industrial computing platforms, data workflow and analysis, cyber-security, human factors, sequential logic control, and case studies of their application in smart manufacturing. Provides the basis for making informed decisions about how manufacturing processes and systems can be designed to be more adaptive (flexible) by automating, collecting the right data, sharing that data, implementing control systems and understanding the impact on humans and organizational systems.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Describe elements of smart manufacturing
Audience: Graduate

2. Identify applications for smart manufacturing in their company and articulate arguments for implementing it as well as challenges that may be encountered
Audience: Graduate

3. Communicate with the various experts that will need to be engaged to implement smart manufacturing
Audience: Graduate

4. Make informed decisions about manufacturing automation, monitoring, control, and human factors
Audience: Graduate

M E 531 – DIGITAL DESIGN AND MANUFACTURING
3 credits.

Broad overview of concepts, methods and tools for manipulating digital geometric models for engineering design and manufacturing. Topics include freeform curves, surfaces, and solid modeling. Topics also include slicing, support generation and path planning for additive and subtractive manufacturing. Provides both cutting-edge knowledge and hands-on project experiences in digital design and manufacturing. It will involve the use of CAD software for creative shape design. It will also involve 3D printers and 3D scanners in the ME Instructional Lab and Maker Space.
Requisites: Senior standing or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019
Learning Outcomes: 1. identify concepts for modeling digital geometric models
Audience: Undergraduate

2. demonstrate skills in modeling complex freeform objects by modeling common engineering components
Audience: Both Grad & Undergrad

3. apply modern concepts and methods in digital geometric design for advanced manufacturing
Audience: Both Grad & Undergrad

4. identify how digital geometric models can be processed into machine instructions for additive and subtractive machines
Audience: Both Grad & Undergrad

5. identify mathematics and computer representations for modeling digital geometric models
Audience: Graduate

M E/COMP SCI/E C E 532 – MATRIX METHODS IN MACHINE LEARNING
3 credits.

Linear algebraic foundations of machine learning featuring real-world applications of matrix methods from classification and clustering to denoising and data analysis. Mathematical topics include: linear equations, regression, regularization, the singular value decomposition, and iterative algorithms. Machine learning topics include: the lasso, support vector machines, kernel methods, clustering, dictionary learning, neural networks, and deep learning. Previous exposure to numerical computing (e.g. Matlab, Python, Julia, R) required.
Requisites: (MATH 234, 320, 340, 341, or 375) and (E C E 203, COMP SCI 200, 220, 300, 301, 302, 310, 320, or placement into COMP SCI 300), graduate/professional standing, or declared in Capstone Certificate in Computer Sciences for Professionals
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Summer 2025
Learning Outcomes: 1. Use matrices and vectors to formulate classification, prediction and matrix completion problems using techniques such as least squares, regularized least squares, the singular value decomposition, subspace methods, support vector machines, neural networks and kernel methods.
Audience: Both Grad & Undergrad

2. Implement machine learning techniques for classification, prediction and matrix completion problems in software, and validate their performance on datasets using cross validation.
Audience: Both Grad & Undergrad

3. Apply advanced techniques to formulate and prove optimality of various matrix based techniques in machine learning.
Audience: Graduate

M E 535 – COMPUTER-AIDED GEOMETRIC DESIGN
3 credits.

Designed to acquaint the student with computer-aided design technology used for geometric design of engineered products. Currently used methods of creating three-dimensional computer-aided design (CAD) models will be discussed. Paradigms of three-dimensional wire-frame modeling, surface modeling and solids modeling as applied in product design. Techniques for freeform curve and surface modeling will be emphasized.
Requisites: Senior standing or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2023
Learning Outcomes: 1. Identify concepts, techniques and mathematics for free-form curves and surfaces modeling
Audience: Both Grad & Undergrad

2. Demonstrate skills in manipulating spline models with CAD software
Audience: Both Grad & Undergrad

3. Apply the concepts and principles to model complex geometric objects
Audience: Both Grad & Undergrad

4. Demonstrate skills in programming geometric objects
Audience: Graduate

M E 536 – DATA DRIVEN ENGINEERING DESIGN
3 credits.

Introduction to data-driven techniques for surrogate modeling based engineering design. Apply data-driven approaches to engineering design problems such as design of structural and thermofluid components and systems.
Requisites: (MATH 234 or 376), (MATH 320, 340, 341, or 375), and (I SY E 210, B M E 325, E C E 331, MATH/STAT 310, STAT 312, 324, 333 or 340), or graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Identify concepts and techniques for data-driven engineering design
Audience: Both Grad & Undergrad

2. Demonstrate skills in constructing surrogate models for design problems
Audience: Both Grad & Undergrad

3. Demonstrate skills in applying data-driven models in design problems
Audience: Both Grad & Undergrad

4. Apply the data-driven methods to solve engineering design problems
Audience: Both Grad & Undergrad

5. Identify mathematics for data-driven engineering design
Audience: Graduate

M E/COMP SCI/E C E 539 – INTRODUCTION TO ARTIFICIAL NEURAL NETWORKS
3 credits.

Theory and applications of artificial neural networks: multi-layer perceptron, self-organization mapdeep neural network convolutional neural network, recurrent network, support vector machines genetic algorithm, and evolution computing. Applications to control, pattern recognition, prediction, and object detection and tracking.
Requisites: COMP SCI 200, 220, 300, 301, 302, 310, placement into COMP SCI 300, or graduate/professional standing
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Summer 2025
Learning Outcomes: 1. Identify if a given data analysis task is a pattern classification problem or a model approximation problem.
Audience: Undergraduate

2. Apply multi-layer perceptron neural network training algorithm to develop artificial neural network (ANN) based pattern classifiers and data predictors.
Audience: Undergraduate

3. Apply deep learning network for pattern classification
Audience: Undergraduate

4. Apply support vector machine (SVM) to develop pattern classifiers.
Audience: Undergraduate

5. Apply self-organization map and k-means to perform clustering operations of a given data set.
Audience: Undergraduate

6. Apply stochastic optimization methods, including simulated annealing, genetic algorithm and random search to solve a discrete optimization problem.
Audience: Undergraduate

M E/E M A 540 – EXPERIMENTAL VIBRATION AND DYNAMIC SYSTEM ANALYSIS
3 credits.

Application of digital data acquisition to the investigation of mechanical components, structures and systems using time histories, transforms and response functions to characterize free, forced and transient inputs. Introduction to sensors, instrumentation and methods appropriate for dynamic system response.
Requisites: (M E 440, E M A 545, or concurrent enrollment) or graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Apply common laboratory techniques to measure dynamic system responses
Audience: Both Grad & Undergrad

2. Demonstrate knowledge of instrumentation, data acquisition, signal processing, and results display for dynamic systems
Audience: Both Grad & Undergrad

3. Formulate analytical models with parameters identified from measured signals
Audience: Graduate

M E 548 – INTRODUCTION TO DESIGN OPTIMIZATION
3 credits.

Introduces basic concepts and techniques used in the optimization of engineering design components and systems. Pose and solve typical optimization problems such as truss and finite-element-based optimization.
Requisites: M E 306 or E M A 303, or graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Translate a loosely worded optimization problem into a mathematical statement
Audience: Both Grad & Undergrad

2. Use the MATLAB optimization toolbox
Audience: Both Grad & Undergrad

3. Apply the fundamental theorems of optimization
Audience: Both Grad & Undergrad

4. Analyze and optimize structural designs
Audience: Both Grad & Undergrad

5. Implement numerical methods of optimization
Audience: Graduate

M E 549 – PRODUCT DESIGN
3 credits.

A project oriented, interdisciplinary course with an emphasis on designing competitive, quality products. The product development process is covered from problem identification through detail design and evaluation. Included among the topics covered are: idea generation and evaluation, visualization, and quality.
Requisites: Senior standing and declared in Biomed, Biological Sys, Chemical, Civil, Computer, Electrical, Geological, Industrial, Mechanical or Nuclear Egr, Materials Sci & Egr, Egr Physics, Egr Mechanics, grad/professional standing or member of Egr Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Apply a structured design methodology to conceive and develop products that are not only feasible but viable and desirable
Audience: Both Grad & Undergrad

2. Integrate a range of low-fidelity prototyping methods and user testing into the design process, as a means of exploring and validating design concepts
Audience: Both Grad & Undergrad

3. Communicate to a diverse audience the ways in which proposed product attributes address user needs, through the use of sketches and storyboards
Audience: Both Grad & Undergrad

4. Situate the role of the engineer in the new product development process, and develop skills to collaborate effectively with peers from different disciplines (marketing, industrial design, human factors, etc.) who work together to bring new products to market
Audience: Both Grad & Undergrad

5. Develop advanced skills to collaborate effectively with peers from different disciplines (marketing, industrial design, human factors, etc.) who work together to bring new products to market
Audience: Graduate

M E 561 – INTERMEDIATE THERMODYNAMICS
3 credits.

Fundamentals; phase and chemical equilibria; availability; thermodynamic relationships.
Requisites: M E 361 or CBE 311, or graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Summer 2025

M E 563 – INTERMEDIATE FLUID DYNAMICS
3 credits.

Incompressible and compressible, laminar and turbulent flow of fluids. Classical and finite-difference analysis using differential and integral formulation of the continuity, momentum and energy equations. Application to ducts, plates, spheres, blades, pumps, turbines, lubrication, shockwaves, nozzles, diffusers and other mechanical engineering equipment.
Requisites: M E 363, or graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2024
Learning Outcomes: 1. Perform a differential and integral analysis of the mass and momentum conservation laws
Audience: Both Grad & Undergrad

2. Develop a mathematical working knowledge of the common manipulations that are performed for three dimensional time-dependent flows
Audience: Both Grad & Undergrad

3. Perform a boundary layer analysis
Audience: Both Grad & Undergrad

4. Develop analytical solutions to selected Navier-Stokes problems including kinematics and potential flows
Audience: Both Grad & Undergrad

5. Implement numerical solution to selected fluid problems
Audience: Graduate

M E 564 – HEAT TRANSFER
3 credits.

Applications of conduction, convection, and thermal-radiation principles to combined-mode problems; analytical and numerical techniques; heat-exchanger design; thermal stresses.
Requisites: M E 364, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Develop analytical models for conduction problems using separation of variables and Laplace transform techniques
Audience: Both Grad & Undergrad

2. Develop high order numerical models of conduction problems using explicit and implicit techniques
Audience: Both Grad & Undergrad

3. Develop models of radiation problems involving semi-grey surfaces using the radiosity technique
Audience: Both Grad & Undergrad

4. Use the Monte Carlo technique to determine view factors
Audience: Both Grad & Undergrad

5. Use the Integral Technique to solve convection problems
Audience: Graduate

M E/N E 565 – POWER PLANT TECHNOLOGY
3 credits.

Design and performance of power plants for the generation of electric power; fossil, solar, wind, hydro and nuclear fuels, cycle analysis, component design and performance, plant operation, control, economics and environmental impact.
Requisites: M E 361, CBE 310, 320, or CIV ENGR 324, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Describe how electricity is produced in a power plant
Audience: Both Grad & Undergrad

2. Apply physical principles to model power plants including power output and efficiency
Audience: Both Grad & Undergrad

3. Observe and collect data on current issues and designs associated to power generation
Audience: Both Grad & Undergrad

4. Describe codes and regulations associated with power production, and how power is sold on the market and transmitted to the customer
Audience: Both Grad & Undergrad

5. Critically review scientific literature pertaining to power plant design
Audience: Both Grad & Undergrad

6. Effectively present detailed information regarding operation and maintenance of power plant components
Audience: Graduate

M E/E P 566 – CRYOGENICS
3 credits.

Applications of cryogenics, material properties at low temperatures, refrigeration and liquefaction systems, measurement techniques, insulation, storage and transfer of cryogenics, safety and handling.
Requisites: (M E 361 or PHYSICS 415) and (CBE 320 or M E 364), or graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019
Learning Outcomes: 1. Describe the similarities and distinctions between the cryogens
Audience: Both Grad & Undergrad

2. Characterize the operation and performance of large scale cryogenic refrigerators and liquefiers
Audience: Both Grad & Undergrad

3. Characterize the operation and performance of recuperative and regenerative cryocoolers
Audience: Both Grad & Undergrad

4. Select appropriate instrumentation to measure temperature, pressure, flow, and level in cryogenic systems
Audience: Both Grad & Undergrad

5. Determine the cooldown time for a cryogenic system including temperature dependent material properties, heat transfer, and refrigeration characteristics
Audience: Both Grad & Undergrad

6. Design a cryogenic system accounting for strength, insulation, fluid flow, and electrical characteristics
Audience: Graduate

M E/CBE 567 – SOLAR ENERGY TECHNOLOGY
3 credits.

Radiant energy transfer and its application to solar exchangers; energy balances for solar exchangers, review of theory, economics, and practice of solar energy applications.
Requisites: (M E 364, CBE 326, or concurrent enrollment), or graduate/professional standing, or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Predict available solar radiation at a given location and time, for a given surface orientation
Audience: Undergraduate

2. Predict and model thermal and optical losses for solar thermal systems
Audience: Undergraduate

3. Calculate the load on a solar system
Audience: Undergraduate

4. Predict and model long term performance of solar thermal systems
Audience: Undergraduate

M E 569 – APPLIED COMBUSTION
3 credits.

Introduction to and analysis of combustion processes and combustion technology for gaseous, liquid, and solid fuels. Application to combustion engines, furnaces, fixed-bed, fluidized-bed, and suspension burning boilers.
Requisites: M E 364, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Develop analytical and computational techniques to analyze combustion chemical kinetics
Audience: Both Grad & Undergrad

2. Apply basic knowledge of combustion problems to understand practical energy conversion devices for power generation
Audience: Both Grad & Undergrad

3. Apply analytical techniques to describe transport-driven combustion phenomena
Audience: Graduate

M E/E M A 570 – EXPERIMENTAL MECHANICS
3 credits.

Experimental methods for design and analysis of mechanical components, structures and materials. Electrically and optically recorded stress, strain and deformation data; computer acquisition/reduction/presentation techniques; applications to static and transient events, sensors, transducer design, NDT, fracture and residual stresses.
Requisites: Senior standing and (M E 306, E M A 303 or 304) or graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2022
Learning Outcomes: 1. Apply knowledge of experimental techniques and measurement systems for mechanical components, structures and materials
Audience: Both Grad & Undergrad

2. Work in groups in the formulation of analytical models, configuration of measurement systems, interpretation of experimental and theoretical results, and presentation of conclusions
Audience: Both Grad & Undergrad

3. Use digital data acquisition systems, computer aided data reduction and display, and commercial software packages for modeling and data analysis
Audience: Both Grad & Undergrad

4. Evaluate clarity and/or accuracy of written work
Audience: Graduate

M E 572 – INTERMEDIATE GAS DYNAMICS
3 credits.

Thermodynamics and fluid dynamics of compressible gas flows with friction and heat transfer, and application to nozzles, shock tubes and propulsion devises. Wave phenomena and engine port tuning. Physics of high temperature gases and equilibrium, non-equilibrium and frozen flows.
Requisites: M E 363, or graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Quantitatively analyze steady and unsteady high-speed flows in one and two dimensions
Audience: Both Grad & Undergrad

2. Apply the method of characteristics to study a wave field
Audience: Both Grad & Undergrad

3. Use Matlab or similar software to solve nonlinear algebraic high-speed flow problems and visualize complex relationships
Audience: Both Grad & Undergrad

4. Use shock and rarefaction polar curves to study wave interactions
Audience: Graduate

M E 573 – COMPUTATIONAL FLUID DYNAMICS
3 credits.

Provides an in-depth introduction to the methods and analysis techniques used in computational solutions of fluid mechanics and heat transfer problems. Model problems are used to study the interaction of physical processes and numerical techniques. Contemporary methods for boundary layers, incompressible viscous flows, and inviscid compressible flows are studied. Finite differences and finite volume techniques are emphasized. Knowledge of programming language such as Python, C++, MATLAB or Java required.
Requisites: M E 363, or graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024

M E/E C E 576 – PRINTED AND FLEXIBLE ELECTRONICS: MANUFACTURING, DEVICES, AND APPLICATIONS
3 credits.

Exploration of additive fabrication of thin-film electronics. Various techniques, materials, and applications of printable electronics with a key focus on mechanically flexible electronic devices. Identify the appropriate printing technology and materials to achieve desired device performance.
Requisites: E C E 230 or 376, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Define the broad field of printed/thin-film electronics
Audience: Both Grad & Undergrad

2. Describe the multiple techniques for printing electronics
Audience: Both Grad & Undergrad

3. Identify the appropriate technique for specific target applications
Audience: Both Grad & Undergrad

4. Describe applications of materials for insulating, conducting, and semiconducting, required for advanced thin-film electronics
Audience: Both Grad & Undergrad

5. Benchmark printed devices including sensors and thin-film transistors
Audience: Both Grad & Undergrad

6. Design printable electronic sensors to desired specifications
Audience: Graduate

7. Describe the current challenges of the field of printable electronics
Audience: Graduate

M E/E C E 577 – AUTOMATIC CONTROLS LABORATORY
4 credits.

Control theory is reduced to engineering practice through the analysis and design of actual systems in the laboratory. Experiments are conducted with modern servo systems using both analog and digital control. Systems identification and modern controls design are applied to motion and torque control.
Requisites: M E 346 or E C E 332, or graduate/professional standing or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2024

M E 578 – MARINE ROBOTICS
3 credits.

Modeling, control, perception, and navigation of autonomous marine robots, including Autonomous Surface Vehicles (ASVs) and Autonomous Underwater Vehicles (AUVs). Core topics include kinematics, dynamics, optimal control, state estimation, perception, communication, and guidance tailored for marine robotic systems. Development and testing of dynamic models, controllers, and perception algorithms on simulated/real marine robot platforms.
Requisites: (M E 340 or concurrent enrollment), (MATH 320 or 376), (PHYSICS 202, 208, or 248), and E C E/M E 439, or graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Learning Outcomes: 1. Explain the core principles of underwater robotics, including kinematics, dynamics, control, localization, and communication
Audience: Both Grad & Undergrad

2. Implement control and perception algorithms for Autonomous Surface Vehicles (ASVs) and Autonomous Underwater Vehicles (AUVs) to achieve specified tasks
Audience: Both Grad & Undergrad

3. Execute simulations/experiments with small autonomous robotic systems and analyze the resulting data to evaluate and improve system performance
Audience: Both Grad & Undergrad

4. Communicate technical findings about marine systems effectively
Audience: Both Grad & Undergrad

5. Assess the environmental and ethical implications of autonomous marine systems
Audience: Both Grad & Undergrad

6. Design optimal control systems for marine robots to ensure robust performance in dynamic and disturbed aquatic environments
Audience: Graduate

M E 601 – SPECIAL TOPICS IN MECHANICAL ENGINEERING
1-3 credits.

Advanced topics of special interest in various areas of Mechanical Engineering, such as vibrations, balancing, lubrication and wear, special manufacturing processes, automation, energy systems, etc.
Requisites: Senior standing or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2025
Learning Outcomes: 1. Identify and describe key theories, concepts, and methods in Mechanical Engineering
Audience: Both Grad & Undergrad

2. Apply key theories, concepts, and methods in Mechanical Engineering, using appropriate tools, processes, and/or software
Audience: Both Grad & Undergrad

3. Apply, Analyze or evaluate advanced theories, concepts, or methods in Mechanical Engineering
Audience: Graduate

M E/B M E 605 – SPECIAL TOPICS IN BIOMECHANICS
1-3 credits.

Various special topics in biomechanics.
Requisites: None
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Learning Outcomes: 1. Identify and describe key theories, concepts, and methods in biomechanics
Audience: Both Grad & Undergrad

2. Apply key theories, concepts, and methods in biomechanics, using appropriate tools, processes, and/or software
Audience: Both Grad & Undergrad

3. Apply, analyze, or evaluate advanced theories, concepts, or methods in biomechanics
Audience: Graduate

M E/B M E 615 – TISSUE MECHANICS
3 credits.

Focus on solid mechanics of prominent musculoskeletal and cardiovascular tissues. Their normal and pathological behaviors (stiffness, strength, relaxation, creep, adaptive remodeling, etc.) in response to physiologic loading will be examined and quantified.
Requisites: M E 306 or E M A 303, or graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Mathematically and conceptually define stress and strain tensors
Audience: Both Grad & Undergrad

2. Calculate stress given a deformation and a constitutive relationship
Audience: Both Grad & Undergrad

3. Describe key features of tissue mechanics
Audience: Both Grad & Undergrad

4. Describe structure-function relationships for biological tissues
Audience: Both Grad & Undergrad

5. Summarize and present current biomechanical knowledge on a specific tissue
Audience: Graduate

M E/I SY E 641 – DESIGN AND ANALYSIS OF MANUFACTURING SYSTEMS
3 credits.

Covers a broad range of techniques and tools relevant to the design, analysis, development, implementation, operation and control of modern manufacturing systems. Case studies assignments using industry data will be used to elaborate the practical applications of the theoretical concepts.
Requisites: I SY E 315, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Identify suitable analysis techniques to investigate processes related to manufacturing, planning, engineering or office operations within a manufacturing firm
Audience: Both Grad & Undergrad

2. Perform analysis to describe, predict and analyze behavior of a manufacturing system to meet desired managerial and economic objectives for a real-world or realistic manufacturing systems improvement project/case study
Audience: Both Grad & Undergrad

3. Develop recommendations that will improve manufacturing system performance (e.g. reduce flow time, increase throughput)
Audience: Both Grad & Undergrad

4. Collaborate effectively in teams to develop solutions to engineering problems and communicate findings effectively
Audience: Both Grad & Undergrad

5. Reflect on personal strengths and weaknesses with respect to team leadership and project management
Audience: Graduate

M E/I SY E 643 – PERFORMANCE ANALYSIS OF MANUFACTURING SYSTEMS
3 credits.

Examines the state of the art in the use of stochastic network theory to develop performance models of modern manufacturing systems.
Requisites: (I SY E 624 or STAT/I SY E/MATH/OTM 632) and (COMP SCI 200, 220, 300, 301, 302, 400, or placement into COMP SCI 300), graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2021
Learning Outcomes: 1. Model a variety of manufacturing problems as stochastic models using Markov Chain and Process theory
Audience: Both Grad & Undergrad

2. Identify the basic assumptions underlying stochastic models and understand what can happen when these assumptions do not hold
Audience: Both Grad & Undergrad

3. Apply queueing theory to model manufacturing systems
Audience: Both Grad & Undergrad

4. Apply the line balancing method for assembly systems design
Audience: Both Grad & Undergrad

5. Perform cost analysis for manufacturing systems
Audience: Both Grad & Undergrad

6. Apply the analytical approaches of performance analysis for manufacturing systems to real industry cases
Audience: Both Grad & Undergrad

7. Apply advanced Markov process method to solve complicated performance evaluation problems encountered in manufacturing production systems
Audience: Graduate

M E 699 – ADVANCED INDEPENDENT STUDY
1-3 credits.

Directed study projects as arranged with instructor.
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2025
Learning Outcomes: 1. Apply advanced physical and mathematical principles to engineering research problems
Audience: Graduate

2. Apply advanced mechanical engineering principles to engineering research problems
Audience: Graduate

3. Communicate technical concepts to a diverse audience via verbal or written media
Audience: Graduate

M E 702 – GRADUATE COOPERATIVE EDUCATION PROGRAM
1-2 credits.

Work experience that combines classroom theory with practical knowledge of operations to provide students with a background on which to develop and enhance a professional career. The work experience is tailored for MS students from within the U.S. as well as eligible international students.
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2025
Learning Outcomes: 1. Identify and respond appropriately to real-life engineering ethics cases relevant to co-op work
Audience: Graduate

2. Synthesize and apply appropriate technical education to real world technical work
Audience: Graduate

3. Communicate effectively in writing and speaking with a range of audiences in the workplace, including those without disciplinary expertise
Audience: Graduate

4. Develop professional and transferable habits like time management skills, collaborative problem-solving skills, and research skills for learning new information
Audience: Graduate

M E/E M A 703 – PLASTICITY THEORY AND PHYSICS
3 credits.

Physical foundations of plasticity as a basis for choices made in the formulation of theories representing plastic deformation and their limitation. Motion of dislocations and formation and growth of deformation twins. Experimental results in the context of plasticity models. Traditional and research topics of plasticity and theories for rate-independent, rate-dependent, single and polycrystal descriptions. Numerical solution of equations and computational plasticity. Knowledge of mechanics of materials [such as E M A 303 or M E 306] and continuum mechanics [such as E M A 622] required.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2023
Learning Outcomes: 1. Identify the physical sources of plastic deformation in materials
Audience: Graduate

2. Explain and apply traditional and advanced theories of plasticity
Audience: Graduate

3. Execute a computational study of plasticity with a common engineering material
Audience: Graduate

4. Given a material model, know how to evaluate the material parameters in the model
Audience: Graduate

5. Provide critical assessment of seminal and modern plasticity literature
Audience: Graduate

M E/E M A 708 – ADVANCED COMPOSITE MATERIALS
3 credits.

Contemporary topics in composite materials, including innovations in sandwich structures, textile composites, and architected materials; fracture mechanics; durability and damage tolerance; experimental techniques; transient, micro, nonlinear, inelastic and environmental effects; advanced manufacturing methods: repair and applications. Knowledge of basic composite materials [such as CIV ENGR/E M A/M E 508] is strongly encouraged.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2016
Learning Outcomes: 1. Describe different types of advanced composites and manufacturing processes
Audience: Graduate

2. Describe the mechanical behavior of various composite materials under different types of loading conditions
Audience: Graduate

3. Mathematically model and solve for engineering stresses and deformations in a composite structure
Audience: Graduate

4. Assess the key challenges and impact of technical work being conducted in the area of composite materials
Audience: Graduate

M E/B M E 715 – ADVANCED TISSUE MECHANICS
3 credits.

Central topics in solid mechanics applied to soft tissues, including analysis of strain in the setting of large deformations, computation of stress in multiple experimental loading configurations, constitutive modeling of biomaterials using hyperelastic strain-energy functions, modeling tissue growth and remodeling, and the main theories for soft tissue failure will be covered. Application of finite elasticity theory in practical laboratory situations, and key papers and concepts in soft tissue mechanics.
Requisites: (M E/B M E 615, E M A 710, or 622 prior to Fall 2024) and graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2023
Learning Outcomes: 1. Compute strain from multiple different types of marker and image data
Audience: Graduate

2. Compute stresses using data from uniaxial, biaxial, and inflation mechanical tests
Audience: Graduate

3. Construct and utilize constitutive models appropriate for soft tissues
Audience: Graduate

4. Formulate and analyze continuum models of biological growth
Audience: Graduate

5. Identify common failure criteria applied to soft tissues
Audience: Graduate

M E 717 – ADVANCED POLYMER PROCESSING
3 credits.

Advanced analysis and modeling of plastics extrusion, injection molding, and other processes; mold and equipment design; materials consideration. Knowledge of polymer processing [such as M E 417] strongly encouraged.
Requisites: Graduate/professional standing or declared in Capstone Certificate in Polymer Processing and Manufacturing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2023

M E 718 – MODELING AND SIMULATION IN POLYMER PROCESSING
3 credits.

This course is designed to acquaint the student with computer simulation technology used for the engineering of polymer processes. Knowledge of polymer processing [such as M E 417] strongly encouraged.
Requisites: Graduate/professional standing or declared in Capstone Certificate in Polymer Processing and Manufacturing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2024

M E/E M A 722 – INTRODUCTION TO POLYMER RHEOLOGY
3 credits.

Formulation of constitutive equations using embedded base vectors. Viscosity, normal stress differences, stress relaxation, elastic recoil. Polymer rheology; homogeneous strain history. Knowledge of differential equations [such as MATH 320] strongly encouraged.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Summer 2023

M E 729 – ADVANCED MACHINING
3 credits.

Advanced topics of mechanical machining process with theory and its applications, material behavior during machining process, 5-axis machining, micro-machining, and difficult-to-cut materials. Ductile to brittle transition of crystalline materials such as metals and ceramics, subsurface damage, and residual stress using theoretical development, empirical observation, and molecular dynamics. Knowledge of metal cutting [such as M E 429], materials science [such as M S & E 350], and manufacturing processes [such as M E 311] required.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Learning Outcomes: 1. Describe techniques for mechanical machining of difficult-to-cut materials
Audience: Graduate

2. Adapt techniques for emerging materials
Audience: Graduate

3. Apply cutting theory, including understanding of ductile to brittle transition, residual stress and subsurface damage, and other advanced topics of machining
Audience: Graduate

4. Identify industry needs for scalable machining processes
Audience: Graduate

5. Identify manufacturing's impact on the global economy, the environment, social paradigms, and government policy
Audience: Graduate

6. Discuss professional and ethical responsibilities of manufacturing practices
Audience: Graduate

M E/E C E 732 – DYNAMICS OF CONTROLLED SYSTEMS
3 credits.

Emphasis on obtaining equations which define the behavior of physical systems frequently subjected to control; mechanical processing, fluid power, and thermal systems; analytical, experimental, and computer techniques. Knowledge of Automatic Controls [such as M E 446 or E C E 322] is required.
Requisites: Graduate/professional standing. Not open to students with credit for M E 746.
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Describe how physical state feedback affects dynamic stiffness of a control system
Audience: Graduate

2. Analyze the sensitivity of the system with eigenvalue migration analysis
Audience: Graduate

3. Develop improved control systems by implementing active state feedback which mimics the physical system and augments the system performance
Audience: Graduate

4. Differentiate command tracking from disturbance rejection. The student will characterize the necessary command feedforward structure in order to achieve optimal command tracking.
Audience: Graduate

5. Manipulate observer inputs and state feedback inputs to achieve zero-lag properties
Audience: Graduate

6. Draw the block diagram of physical systems identifying the appropriate inputs required for a properly formed observer
Audience: Graduate

7. Implement observers for state estimation in multi-variable control systems
Audience: Graduate

M E/E C E 733 – ADVANCED COMPUTER CONTROL OF MACHINES AND PROCESSES
3 credits.

Digital control theory, design methodology, and techniques for controller implementation on digital computers. Advanced single and multi-axis motion generation algorithms. Multiple processor control systems. Multiple objective control systems for machinery guidance and manufacturing processes. Precision control. Knowledge of continuous and discrete time control [such as M E 447 or E C E 332] is required.
Requisites: Graduate/professional standing. Not open to students with credit for M E 747.
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Learning Outcomes: 1. Explain and apply physics-based discrete time system modeling
Audience: Graduate

2. Analyze and design in both the continuous and discrete domains
Audience: Graduate

3. Analyze and design control systems using tools such as Matlab and Simulink
Audience: Graduate

4. Describe physics-based control structures for computer control systems
Audience: Graduate

M E 737 – SCIENTIFIC COMPUTING AND MACHINE LEARNING FOR ENGINEERING APPLICATIONS
3 credits.

Key computational topics for engineering applications will be discussed, encompassing both established classical numerical methods and the emerging field of machine learning. Knowledge of calculus [such as MATH 221], linear algebra and differential equations [such as MATH 320], probability [such as MATH 331] and programming in Python or MATLAB [such as COMP SCI 220] is required.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Learning Outcomes: 1. Implement representative machine learning methods for regression analysis to solve engineering problems
Audience: Graduate

2. Apply both classical numerical methods and machine learning techniques to solve Ordinary Differential Equations (ODEs) and Partial Differential Equations (PDEs)
Audience: Graduate

3. Evaluate the strengths and weaknesses of classical numerical methods and machine learning techniques for solving engineering problems
Audience: Graduate

4. Develop reduced-order models to accelerate computation
Audience: Graduate

M E 740 – ADVANCED VIBRATIONS
3 credits.

Vibration of mechanical components subject to dynamic loads; analytical, numerical and finite element methods applied to the analysis and design of mechanical systems consisting of cables, bars, shafts, beams, frames, rings, membranes, plates and shells. Knowledge of vibrations [such as M E 440] strongly encouraged.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2023

M E 746 – DYNAMICS OF CONTROLLED SYSTEMS
3 credits.

Emphasis on obtaining equations which define the behavior of physical systems frequently subjected to control; mechanical processing, fluid power, and thermal systems; analytical, experimental, and computer techniques. Knowledge of Automatic Controls [such as M E 446 or E C E 332] is required.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2022
Learning Outcomes: 1. Describe how physical state feedback affects dynamic stiffness of a control system
Audience: Graduate

2. Analyze the sensitivity of the system with eigenvalue migration analysis.

Audience: Graduate

3. Develop improved control systems by implementing active state feedback which mimics the physical system and augments the system performance.
Audience: Graduate

4. Differentiate command tracking from disturbance rejection. The student will characterize the necessary command feedforward structure in order to achieve optimal command tracking.
Audience: Graduate

5. Manipulate observer inputs and state feedback inputs in order to achieve zero-lag properties.
Audience: Graduate

6. Draw the block diagram of physical systems identifying the appropriate inputs required for a properly formed observer.
Audience: Graduate

7. Implement observers for state estimation in multi-variable control systems.
Audience: Graduate

M E 747 – ADVANCED COMPUTER CONTROL OF MACHINES AND PROCESSES
3 credits.

Digital control theory, design methodology, and techniques for controller implementation on digital computers. Advanced single and multi-axis motion generation algorithms. Multiple processor control systems. Multiple objective control systems for machinery guidance and manufacturing processes. Precision control. Knowledge of digital control [such as M E 447] strongly encouraged.
Requisites: (M E 446 or E C E 332) and graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2023

M E 748 – OPTIMUM DESIGN OF MECHANICAL ELEMENTS AND SYSTEMS
3 credits.

Formulation and solution of mechanical design problems by use of mathematical programming methods.
Requisites: M E 548 and graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025

M E 751 – ADVANCED COMPUTATIONAL DYNAMICS
3 credits.

Overview of techniques used to understand the time evolution (dynamics) of multi-body mechanical engineering systems. Modeling, equation formulation, and numerical methods used to determine the dynamics of multi-body mechanical systems. Rigid and flexible multi-body dynamics, friction and contact. Knowledge of Python or MATLAB strongly recommended. Knowledge of dynamic systems [such as M E 240 or 340] required.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2020
Learning Outcomes: 1. Solve problems that pertain to the Kinematics and Dynamics of complex mechanical systems (mechanisms) made up of both rigid and deformable bodies
Audience: Graduate

2. Formulate basic multi-physics models
Audience: Graduate

3. Use Matlab or Python programming to produce a simulation engine that draws on the concepts introduced in this class
Audience: Graduate

4. Use third party software to solve real-life problems tied to mechanical systems that include rigid and compliant elements and might interact with a fluid
Audience: Graduate

M E 753 – FRICTION, LUBRICATION AND WEAR
3 credits.

Behavior of frictional surfaces under different types of loading. Mechanisms of heat generation and surface damage (wear, scuffing, pitting, fretting, etc.). Rheological effects. Effect of lubrication. Surface interaction in metal cutting. Design considerations. Knowledge of mechanics/strength of materials [such as E M A 303 or M E 306] strongly encouraged.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2024

M E 758 – SOLID MODELING
3 credits.

Mathematical modeling, computer representations, and algorithms for manipulation of two- and three-dimensional shapes on a computer. Applications of shape modeling to design, representation, and analysis of mechanical parts and processes; other engineering and scientific applications of shape and solid modeling. Knowledge of advanced programming [such as COMP SCI 400] and knowledge of linear algebra [such as MATH 340] strongly encouraged.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2020
Learning Outcomes: 1. Utilize advanced mathematical representations of shapes
Audience: Graduate

2. Translate mathematical representations to computer algorithms
Audience: Graduate

3. Apply shape modeling to design problems
Audience: Graduate

M E/COMP SCI/E C E/E M A/E P 759 – HIGH PERFORMANCE COMPUTING FOR APPLICATIONS IN ENGINEERING
3 credits.

An overview of hardware and software solutions that enable the use of advanced computing in tackling computationally intensive Engineering problems. Hands-on learning promoted through programming assignments that leverage emerging hardware architectures and use parallel computing programming languages. Students are strongly encourage to have completed COMP SCI 367 or COMP SCI 400 or to have equivalent experience.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025

M E 761 – TOPICS IN THERMODYNAMICS
3 credits.

Thermostatic behavior of nonideal gases; equations of state, with emphasis on their empirical and statistical development, including mixture rules; more detailed study of chemical and phase equilibrium; selected applications of the foregoing; real gas processes, combustion, direct energy conversion devices. Knowledge of thermodynamics [such as M E 561] strongly encouraged.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Summer 2025

M E 764 – ADVANCED HEAT TRANSFER I-CONDUCTION
3 credits.

Analytical methods in conduction; Bessel functions, separation of variables, Laplace transforms, superposition, oscillating solutions; computer methods; finite differences, finite elements. Knowledge of basic heat transfer [such as M E 564] strongly encouraged.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Summer 2025
Learning Outcomes: 1. Use Duhamel's theorem to solve conduction problems
Audience: Graduate

2. Use Complex Combination to solve conduction problems
Audience: Graduate

3. Use Separation of Variables to solve conduction problems
Audience: Graduate

4. Use Superposition to solve conduction problems
Audience: Graduate

5. Use Finite Difference and Finite Element techniques to solve conduction problems
Audience: Graduate

M E 768 – PRECISION MEASUREMENTS
3 credits.

General concepts for predicting, characterizing, and reducing noise in measurements. Address the key questions of all experimentalists: (1) How can I improve my signal-to-noise ratio? (2) What is the ultimate detection limit of my measurement approach? Knowledge of Matlab programming and basic circuit design [such as E C E 230] is required.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Differentiate between different sources of measurement noise
Audience: Graduate

2. Employ noise circuit analysis to predict the detection limit of a measurement
Audience: Graduate

3. Characterize measurement noise in the frequency domain
Audience: Graduate

4. Design and test analog filter circuits
Audience: Graduate

5. Implement lock-in detection techniques to measure small signals
Audience: Graduate

M E 769 – COMBUSTION PROCESSES
3 credits.

Combustion theory and practice. Thermodynamics of combustion, flame theory, detonation, spray and droplet combustion related to various engine applications. Knowledge of internal combustion engines [such as M E 469], thermodynamics [such as M E 561], and combustion [such as M E 569] strongly encouraged.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2023
Learning Outcomes: 1. Write computer code to solve equilibrium combustion problems
Audience: Graduate

2. Write computer code to solve zero-dimensional transient combustion problems
Audience: Graduate

3. Write computer code to solve transport equations for a one-dimensional reacting flow
Audience: Graduate

4. Perform design level calculations using a commercial computational fluid dynamics or chemical kinetics code
Audience: Graduate

M E 770 – ADVANCED EXPERIMENTAL INSTRUMENTATION
3 credits.

Theory and design of instruments for transient physical phenomena especially related to internal combustion engines. Basic knowledge of kinetic theory of gases, statistical mechanics, and quantum mechanics for gases, and measurement theory [such as M E 601: Physics of Gases] required.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2023
Learning Outcomes: 1. Identify sources of systematic and random uncertainties for measurement systems
Audience: Graduate

2. Perform uncertainty analysis for complex systems
Audience: Graduate

3. Define vocabulary and nomenclature associated with optical and laser-based diagnostics
Audience: Graduate

4. Perform basic optics calculations and gaussian beam propagation calculations
Audience: Graduate

5. Apply knowledge of physics to estimate diagnostic performance
Audience: Graduate

M E 774 – CHEM KINETICS OF COMBUST SYSTEMS
3 credits.

Application of gas-phase chemical reaction rate theory to power and propulsion systems, both earthbound and airborne. Aerothermochemistry, kinetics of combustion reactions, kinetics related to air pollutant generation. Development and comparison of transition state theory, collision theory and bond-energy-bond-order method. Intermediate knowledge of thermodynamics and combustion and basic understanding of kinetic theory of gases, statistical mechanics, and quantum mechanics for gases [such as M E 601: Physics of Gases] required.
Requisites: M E 569 and graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2022
Learning Outcomes: 1. Define terminology associated with kinetics and reaction dynamics
Audience: Graduate

2. Solve chemical equilibrium using the method of element potentials
Audience: Graduate

3. Apply reaction rate theories for bimolecular and unimolecular reactions to estimate rate coefficients
Audience: Graduate

4. Solve and analyze reaction mechanisms using computational tools
Audience: Graduate

5. Identify dominant ignition pathways for hydrocarbon fuels
Audience: Graduate

M E/CIV ENGR/E M A 775 — TURBULENT HEAT AND MOMENTUM TRANSFER
3 credits.

Stochastic methods in turbulent heat and momentum transfer; fully developed turbulence; numerical methods including model applications to boundary layers, reacting flows, mass transfer, and unsteady flows; linear and non-linear stability and transition; emphasis on applications of interest to Mechanical, Aerospace, and Environmental Engineers. Knowledge of fluid mechanics [such as M E 363 or CBE 320] strongly encouraged.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Describe the physics and mathematics of turbulence theory and modeling
Audience: Graduate

2. Describe general features of turbulence
Audience: Graduate

3. Use analysis tools to solve problems and process data related to turbulence
Audience: Graduate

4. Use turbulence concepts to understand and explain turbulent behavior in more complex systems
Audience: Graduate

M E/E P 777 — VACUUM TECHNOLOGY
3 credits.

Topics defining modern vacuum technology, including the kinetic theory of gases, conductance, pumping systems, pump technologies, pressure measurement, gas-surface interactions, sealing technologies, leak detection, and residual gas analysis will be addressed through a combination of lectures, laboratory activities, problem solving, and group discussions. Knowledge of fluid mechanics [such as M E 363 or B M E 320] strongly encouraged.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2022
Learning Outcomes: 1. Use kinetic theory to determine key characteristics of a rarified gas such as the mean free path length, molecular flux and the average velocity
Audience: Graduate

2. Calculate the conductance of a vacuum system for molecular, viscous, and transitional flow regimes
Audience: Graduate

3. Calculate the time dependent pump down behavior of a vacuum system

Audience: Graduate

4. Repair a rotary vane vacuum pump
Audience: Graduate

5. Characterize the operation, advantages and disadvantages of low, medium, and high vacuum pumps
Audience: Graduate

6. Characterize the operation, advantages and disadvantages of low and high vacuum gauges
Audience: Graduate

7. Define and utilize appropriate leak detection methods for small, medium, and large leak rates
Audience: Graduate

M E 790 — MASTER'S RESEARCH AND THESIS
1-9 credits.

Directed study projects as arranged with instructor.
Requisites: Declared in a Mechanical Engineering graduate program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2025

M E 890 – PHD RESEARCH AND THESIS
1-9 credits.

Directed study projects as arranged with instructor.
Requisites: Declared in a Mechanical Engineering graduate program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2025

M E 903 – GRADUATE SEMINAR
0 credits.

Topics vary.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2025

M E 964 – SPECIAL ADVANCED TOPICS IN MECHANICAL ENGINEERING
1-3 credits.

Advanced topics in design, manufacturing, energy, etc.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2025
Learning Outcomes: 1. Identify and describe key theories, concepts, and methods in mechanical engineering
Audience: Graduate

2. Apply key theories, concepts, and methods in mechanical engineering, using appropriate tools, processes, and/or software
Audience: Graduate

3. Apply, analyze, or evaluate advanced theories, concepts, or methods in mechanical engineering
Audience: Graduate

M E 990 – DISSERTATOR RESEARCH AND THESIS
1-9 credits.

Directed study projects as arranged with instructor.
Requisites: Declared in Mechanical Engineering PhD
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2025

M E 999 – ADVANCED INDEPENDENT STUDY
1-5 credits.

Directed study projects as arranged with instructor.
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2024