Department of Mechanical Engineering

Mechanical Engineering

The broad discipline of mechanical engineering enables students to have productive and rewarding careers, and to develop and improve new technologies in both traditional an emerging fields. Mechanical engineers apply fundamental principles to develop, design, manufacture, and test machines and other mechanical devices. Such devices include but are not limited to power-producing machines as well as power-consuming machines. Mechanical engineers are employed in diverse areas including but not limited to: the energy and power industries, the automotive and aerospace industries, and industrial manufacturing. Mechanical Engineering graduates also have careers in medicine and medical device development, patent law, engineering and corporate management, forensic engineering, and engineering sales.

The mission of the Mechanical Engineering Department is to provide our students with a high quality education, to generate and apply knowledge, and to serve both society and the engineering profession.

In support of our mission, upon graduation our undergraduate students will be:

1. technically skilled in the application of the principles of mechanical engineering, and will demonstrate the ability to work collaboratively and in teams;
2. successful in their chosen career paths, demonstrating the attitudes, abilities, and personal leadership to effectively adapt to our changing global society while maintaining and promoting the highest engineering, professional, and ethical standards; and
3. actively engaged in continuous learning and professional growth throughout their careers while productively contributing to their organizations and communities.

In support of our mission, upon graduation our graduate students will be:

1. capable of performing research at the highest possible level and contribute valuable advances to their chosen areas of specialization;
2. enthusiastic and have a strong desire to instruct young engineers in their chosen areas of specialization; and
3. qualified to work at the most prestigious research institutions and universities in the world.

Undergraduate Programs

The Department of Mechanical Engineering offers a 128-hour bachelor of science degree in mechanical engineering. The Bachelor of Science degree in mechanical engineering is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. Students interested in biomedical engineering or applying to medical school after graduation may elect to complete a concentration in biomechanics (or follow a pre-medicine plan)) or complete an Undergraduate Certificate in Bioengineering (see the Bioengineering program for requirements).

There is also a four and one-half year MBA bridge program in which students earn a B.S. in mechanical engineering as well as a MBA degree.

Depending on the employer, mechanical engineering graduates might be expected to become licensed. Formal study in an accredited engineering program, such as at the University of Kansas, is the first step to becoming licensed in Kansas and other states. After completion of a majority of coursework, students are encouraged to take the Fundamentals of Engineering examination which is necessary to become a licensed Professional Engineer (P.E.).

The mechanical engineering curriculum builds on the basic foundation of mathematics and physical sciences, and focuses on engineering design and analysis in 2 primary areas:

1. Mechanical systems.
2. Thermal, fluids, and energy systems.

Engineering science, analysis, and design is integrated throughout the curriculum, culminating in a senior capstone design project where students complete a year-long, hands-on design and build experience in one of four areas:

- Formula SAE vehicle design,
- Industrial sponsored topics, and
- Research sponsored topics.

The industrial and/or research projects may include alternative energy topics (EcoHawks), biomechanics topics or general mechanical engineering topics.

Graduate Programs

The University of Kansas Department of Mechanical Engineering offers the Master of Science in Mechanical Engineering degree and the Doctor of Philosophy. Areas of study in Mechanical Engineering include:

1. **Biomechanics and Biomaterials:** biomechanics of human motion, biomaterials, orthopedic biomechanics and biomedical product design, transport phenomena, and drug delivery.
2. **Computational Mechanics and Mathematics of Computations:** computational mechanics, finite element analysis, finite element methods and software
3. **Thermal-Fluid Systems and Heat Transfer:** energy and thermal-power system design, heat transfer and computational fluid dynamics
4. **Mechanical Design, Manufacturing, and Microprocessor Applications:** computer-aided mechanical design, continuum mechanics, computer-integrated manufacturing, computational mechanics, finite element analysis, machine stress analysis, microcomputer applications, and automatic control systems

Graduate Admission

Please review the corresponding pages for admission to the MS or PhD programs:

- Master of Science (http://catalog.ku.edu/engineering/mechanical-engineering/ms/#admissionstext)
- Doctor of Philosophy (http://catalog.ku.edu/engineering/mechanical-engineering/phd/#admissionstext)

Graduate Financial Aid

All applicants are considered for scholarships, fellowships, and Graduate Teaching Assistant (GTA) positions upon submission of a complete application. It is suggested that applicants complete their applications by the priority deadlines (December 15 for Fall applicants; September 30 for Spring applicants) to ensure consideration before positions are filled. The department offers funding opportunities for first-year graduate students. Graduate Research Assistant (GRA) positions are dependent on faculty research (http://me.engr.ku.edu/faculty-research/) and applicants should contact individual faculty members regarding their research openings. Note: Graduate students who meet the prerequisite eligibility (https://selfgraduate.ku.edu/eligible-disciplines/) and have completed an application by December 15 will be considered by our Admissions Committee for nomination for the Self Graduate Fellowship (https://selfgraduate.ku.edu/). Information regarding the benefits available to GTAs and GRAs can be found in the KU Policy Library (https://policy.ku.edu/graduate-studies/benefits-for-GRAs-GTAs-GAs/).

Courses

ME 101. Mechanical Engineering Freshman Seminar. 0-1 Hours.
This seminar is intended to provide the student with an overview of the mechanical engineering profession. Seminar topics will include an overview of the engineering profession, career opportunities within mechanical engineering, an introduction to the mechanical engineering department (faculty, research and student groups), and strategies to be successful at the university. Prerequisite: Fewer than 30 credit hours from the University of Kansas. LEC.

ME 201. Statics. 2 Hours.
The principles of statics, with particular attention to engineering applications. Prerequisite: PHSX 210 or PHSX 211. LEC.

ME 208. Introduction to Digital Computational Methods in Mechanical Engineering. 3 Hours.
Digital computing methods for solving mechanical engineering problems utilizing current programming languages and commercial software. Topics from the course are applied through open-ended team projects throughout the semester which also give students an introduction to mechanical engineering. One lecture and lab meets with ME 228, therefore ME 208 cannot be taken concurrently with ME 228, but should be taken in back-to-back semesters. Prerequisite: Corequisite: MATH 116 or MATH 125. LEC.

ME 210. Introduction to Mechanics. 1 Hour.
An introduction to mechanics of materials including stress, strain, and axial loading. Prerequisite: ME 201 or CE 201. LEC.

ME 211. Statics and Introduction to Mechanics. 3 Hours.
The principles of statics, with particular attention to engineering applications and an introduction to mechanics of materials. This course is a combination of material covered in ME 201 and ME 210. Prerequisite: PHSX 210 or PHSX 211 or PHSX 213 or PHSX 201. LEC.

ME 212. Basic Engineering Thermodynamics. 3 Hours.
An introduction to the concepts of heat, work, the first and second laws of thermodynamics and equations of state. These concepts are applied to flow and nonflow systems including power and refrigeration cycles. Prerequisite: PHSX 210 or PHSX 211 or PHSX 201 and MATH 126 or MATH 146, with a grade of C- or higher. LEC.

ME 228. Computer Graphics. 3 Hours.
An introduction to solid modeling computer graphics used in mechanical design. Visualization skills and drawing practices are developed. Topics from the course are applied through open-ended team projects throughout the semester which also give students an introduction to mechanical engineering. One lecture and lab meets with ME 208, therefore ME 228 cannot be taken concurrently with ME 208, but should be taken in back-to-back semesters. Prerequisite: Corequisite: MATH 104. LEC.

ME 306. Science of Materials. 3 Hours.
An introductory course on materials. Emphasis is placed on structure and the relation of structure to the behavior and properties of engineering materials. Prerequisite: CHEM 150 or CHEM 130 or CHEM 170 or consent of instructor. LEC.

ME 307. Engineering Materials Laboratory. 2 Hours.
Laboratory to supplement lecture on engineering materials properties and selection, manufacturing processes, and design for manufacturing. Prerequisite: CHEM 150 or CHEM 130 or CHEM 170 and ME 228. Corequisite: ME 306 and ME 311. LAB.

ME 309. Introduction to Mechanical Design. 1 Hour.
An introduction to mechanical design after completing a course in mechanics of materials. Topics include theories of failure and energy methods. ME 201, CE 310, and ME 309 together are equivalent to ME 211 and ME 311. Prerequisite: Permission of instructor. LEC.

ME 311. Mechanics of Materials. 3 Hours.
The principles of mechanics of materials with particular emphasis on mechanical systems including theories of failure. Prerequisite: ME 211 or ME 210 with a grade of C- or higher, and MATH 126 or MATH 146, with a grade of C- or higher. LEC.

ME 320. Dynamics. 3 Hours.
Kinematics and kinetics of particles and of rigid bodies as applied to mechanical engineering problems. Prerequisite: ME 201 or ME 211, with a grade of C- or higher, and MATH 220, and MATH 290. LEC.

ME 321. Dynamics Simulations. 1 Hour.
Introduction to dynamics simulations on the computer. Prerequisite: Corequisite: ME 320. LAB.

ME 360. Mechanical Engineering Problems. 1-3 Hours.
An analytical or experimental study of problems or subjects of immediate interest to a student and faculty member and which is intended to develop student capability for independent research or application of engineering science and technology. After completion of the project, a report is required. Maximum credit is three hours. Not open to students who have taken ME 361. Prerequisite: Approval of an outline of the proposed project by the instructor and department chair. IND.

ME 361. Undergraduate Honors Research. 1-3 Hours.
Investigation of a particular mechanical engineering problem. Research will involve defining the problem, developing a research methodology, applying the research methodology and gathering data, analyzing and interpreting the data, and presenting the results of the research. The student must have a faculty sponsor and submit a proposal in writing stating the objective of the research, the planned research method that will be used, and the method of reporting the results. Maximum credit is three hours. Not open to students who have taken ME 360. Prerequisite: Participation in the University Honors Program, consent of instructor, and approval of the chair required. IND.

ME 390. Special Topics: _____. 1-5 Hours.
Courses on special topics of current interest in mechanical engineering, given as the need arises. Prerequisite: Approval of instructor. LEC.

ME 412. Thermal Systems. 3 Hours.
Application of the principles of thermodynamics to the analysis and design of thermal systems. Prerequisite: ME 212 or ME 312. LEC.

ME 420. Mechanisms. 3 Hours.
Design and analysis of mechanisms composed of linkages, cams, and gears. Mechanical vibration. Prerequisite: PHSX 211 and MATH 220. LEC.

ME 455. Mechanical Engineering Measurements and Experimentation. 4 Hours.
Lectures and laboratories on the basics of measurement, instrumentation, data acquisition, analysis, design and execution of experiments, and written and oral reports. Topics selected from heat transfer, fluid mechanics, thermodynamics, mechanics, strength of materials, and dynamics. Prerequisite: ME 208, ME 307, ME 320, and MATH 365 or MATH 526. Corequisite: EECS 318 and ME 612. LEC.

ME 501. Mechanical Engineering Design Process. 2 Hours.
The design process of a mechanical or thermal system. Establishment of specifications and consideration of realistic constraints such as safety, codes, economic factors, reliability, oral and written communications, and other factors as they impact the design process. Prerequisite: ME 228 and ME 311. LEC.

ME 508. Numerical Analysis of Mechanical Engineering Problems. 3 Hours.
Introduction to numerical methods for solution of mechanical engineering problems by use of digital computers. Prerequisite: ME 208 or equivalent, MATH 220 and MATH 290. LEC.

ME 510. Fluid Mechanics. 3 Hours.
An introduction to the mechanics of fluid flow. The principles of conservation of mass, momentum, and energy are developed in differential and integral form. Laws of dimensional analysis and similitude are presented as the basis for empirical correlations. Engineering applications include: calculation of hydrostatic forces on submerged objects, analysis of flow and pressure loss in piping systems, estimation of aerodynamic lift and drag, and performance characteristics of pumps and fans. Prerequisite: ME 211, ME 201, or CE 201 with a grade of C- or higher, and MATH 122 or MATH 127 and ME 212 or ME 312, with a grade of C- or higher. LEC.

ME 590. Special Topics: _____. 1-5 Hours.
Courses on special topics of current interest in mechanical engineering, given as the need arises. Prerequisite: Approval of instructor. LEC.

ME 612. Heat Transfer. 3 Hours.
An applied study of conductive, convective, and radiative heat transfer mechanisms in solid and fluid systems. Engineering applications include solid conduction, free and forced convection in fluids, thermal radiation and heat exchangers, evaporators, and furnaces. Prerequisite: MATH 220 and ME 510 or CPE 511. LEC.

ME 617. Research for Design Project Option B. 1 Hour.
Basic research in one targeted area of vehicle design, and competition rules, based on the student's plan for ME 627 and ME 642. Prerequisite: ME 501 and permission of instructor. RSH.

ME 627. Automotive Design. 3 Hours.
Basic concepts of automotive design and manufacture. Primary focus of course on vehicle design and performance. Design is subdivided into vehicle components of frame, suspension, front and rear axle, steering power train, front and rear wheel drive, and braking. Integration of these ideas into a vehicle design project with analysis of its performance culminates the course. Prerequisite: ME 617 and permission of instructor. LEC.

ME 628. Mechanical Design. 3 Hours.
Design of mechanical components and systems. Prerequisite: ME 311. LEC.

ME 633. Basic Biomechanics. 3 Hours.
Provides an overview of musculoskeletal anatomy. Biodynamics includes linear and angular dynamics of human movement, energy expenditure and power required to perform a given activity. Students will learn to determine joint forces and torques (in 2-D) from kinematic data for body segments and force plate data. The tissue mechanics section builds on mechanics of materials. Students will learn about tissue properties, appropriate constitutive models and determination of stresses and strains in tissues and structures under normal loading conditions. Prerequisite: ME 311 and ME 320 or equivalent. LEC.

ME 636. Internal Combustion Engines. 3 Hours.
Study and analysis of internal combustion engine physical phenomena dynamic function, components, and system design. Emphasis on spark ignition and compression ignition engine analysis. Performance, current technology, thermodynamics, fluid-mechanics, combustion products and pollution, fuels and lubrication, and mechanical design. Prerequisite: ME 412. LEC.

ME 637. Steam Power Plants. 3 Hours.
A study of steam power plant equipment including thermodynamic analysis, design and performance of modern steam generators, prime movers, and auxiliaries. Prerequisite: ME 412 or permission of instructor. LEC.

ME 639. Alternative Energy Systems. 3 Hours.
This course is a survey of energy resources and the available technology for meeting current energy needs with alternative energy systems. An overview of the U.S. energy system and world-wide energy consumption is included to provide context. The primary course objective is to develop the students' ability to apply engineering fundamentals to the design and operation of alternative energy systems. The students will be introduced to databases and modeling methods used to represent alternative energy resources. Assignments will include: engineering problem analysis, group design projects, individual research papers, oral and written presentations. Prerequisite: ME 510, AE 345, or CPE 511 and (ME 412 or ME 612 or CPE 521). LEC.

ME 640. Design Project. 2 Hours AE61.
Planning for a capstone design project. Development of a formal project proposal is required. Must be used with two credit hours of ME 641 or ME 643 in the subsequent semester to complete the capstone design requirements. Prerequisite: ME 501 and ME 628. LEC.

ME 641. Design Project Option A. 2 Hours AE61.
Design and development of a mechanical or thermal/fluid system. An individual or group report that includes designs, analysis/testing, drawings, and/or schematics is required. Establishment of specifications and consideration of realistic constraints such as safety, economic factors, design impact, aesthetics, and reliability are required. Prerequisite: ME 501, ME 510, ME 628 and ME 640. Corequisite: ME 455. LEC.

ME 642. Design Project Option B. 3 Hours AE61.
Manufacturing and testing of a mechanical system designed and developed in ME 627 - Vehicle Design. A group report with individual assignments which details the manufacturing procedures and testing procedures and results is required. A completed, working project with a design file documenting all aspects of the project development must be submitted. Prerequisite: ME 627, ME 501 and ME 628. Corequisite: ME 455. LEC.

ME 643. Design Project Option C. 2 Hours AE61.
Design and development of a mechanical system related to biomechanics that has been investigated in ME 633 - Basic Tissue Mechanics and Biodynamics. A report that includes designs, analysis/testing, drawings and/or schematics is required. Establishment of specifications and consideration of realistic constraints such as safety, ergonomics, economic factors, design impact, aesthetics, and reliability are required. Prerequisite: ME 501, ME 628, ME 633 and ME 640. Corequisite: ME 455. LEC.

ME 644. Design Project Option D. 2-3 Hours AE61.
Design and development of a thermal or fluid system. A group report that includes design, analysis/testing, drawings, and/or schematics is required. Establishment of specifications and consideration of realistic constraints such as safety, economic factors, design impact, aesthetics, and reliability are required. Prerequisite: ME 412, ME 455, and ME 501. Corequisite: ME 628. LEC.

ME 645. Design Project Option E. 2-3 Hours AE61.
Design and development of a mechanical, electrical or thermal/fluid system related to a sustainable approach to automobiles and energy infrastructure. This may include, but is not limited to alternative fuels, biomass, batteries and advanced vehicle powertrains along with solar/wind energy at various scales. An individual or group report that includes designs, analysis/testing, drawings and/or schematics is required. Establishment of specifications and consideration of realistic constraints such as safety, economic factors, design impact, aesthetics and reliability are required. Prerequisite: ME 501, ME 510, and ME 628. Corequisite: ME 412 and ME 455. LEC.

ME 661. The Finite Element Method. 3 Hours.
An introduction to the underlying theory of the finite element (FE) method and its application to linear solid and structural mechanics. FE formulations are derived for bars, beams, 2D formulations such as: plane stress, plane strain, and 3D solids. Basic issues are treated such as assembly and generation of FE equations, computation, post-processing, and interpretation of FE solutions (e.g. stresses and strains analysis). Prerequisite: ME 311, MATH 220, and MATH 290. LEC.

ME 682. System Dynamics and Control Systems. 3 Hours.
An introduction to the modeling and analysis of analog linear systems and the design of control systems. Topics include mathematical models of mechanical, electrical, fluid and thermal systems, feedback concepts, transient response, frequency response and vibration, system stability, and design of feedback control systems including PID. Prerequisite: ME 320. LEC.

ME 696. Design for Manufacturability. 3 Hours.
Tools to incorporate manufacturing and life-cycle concerns into the design of products. Prerequisite: ME 501 or equivalent. LEC.

ME 702. Mechanical Engineering Analysis. 3 Hours.
A study of advanced methods for engineering analysis of practical problems utilizing fundamental principles from engineering disciplines. The emphasis is on the solution of these problems and the interpretation and generalization of the results. Prerequisite: A course in differential equations. LEC.

ME 708. Microcomputer Applications in Mechanical Engineering. 3 Hours.
Design and implementation of interfaces of microcomputers to mechanical equipment. Includes laboratory experiments presenting selected industrial applications. Emphasis on human factors, functional design parameters and microprocessor interfaces. Includes instruction concerning specifications of practical hardware configurations and writing of programs necessary to accomplish mechanical systems applications. Prerequisite: Permission of instructor. LEC.

ME 711. Bearings and Bearing Lubrication. 3 Hours.
Theoretical aspects of lubrication, determination of pressure distribution in bearings from viscous flow theory, application of hydrodynamic and hydrostatic bearing theories to the design of bearings, high speed bearing design problems, properties of lubricants, methods of testing. Prerequisite: ME 510 and a course in differential equations. LEC.

ME 712. Advanced Engineering Thermodynamics. 3 Hours.
An advanced course in thermodynamics, mathematical in nature, with emphasis on a critical re-evaluation of the laws of thermodynamics, thermodynamics of one-dimensional gas flow, development of the classical thermodynamic relations and their application to engineering problems. Prerequisite: ME 508 and ME 412. LEC.

ME 716. Introduction to Surface and Interface Science. 3 Hours.
Surface and Interface Science plays a crucial role in various industrial, environmental, and biomedical areas, as well as in emerging technologies. These include wetting, water purification, enhanced oil recovery and other petrochemical processes. Surface and Interface Science also provides an intriguing arena for the integration of fundamental concepts, theoretical methods, and experimental techniques from a variety of scientific disciplines including engineering, physics, chemistry, biology, and medicine. This course presents fundamental and applied aspects of this rapidly developing field. The first segment of the course is devoted to understanding interfacial phenomena by examining the roles of surface composition and surface texture. The second segment covers how this fundamental understanding can be used to design bio-inspired surfaces for various applications that involve self-cleaning mechanisms, anti-reflective coating, fog harvesting and de-icing. Prerequisite: ME 312 or physical chemistry or equivalent. LEC.

ME 718. Fundamentals of Fuel Cells. 3 Hours.
The principles of fuel cells, with focus on low temperature fuel cells using polymer electrolytes. Prerequisite: A course in engineering thermodynamics (e.g., ME 412), heat transfer (e.g., ME 612), and fluid Mechanics (e.g., ME 510.) LEC.

ME 720. Advanced Dynamics of Machinery. 3 Hours.
Dynamics of particles and of rigid bodies with advanced engineering applications; generalized coordinates; Hamilton's principles; Lagrange's equations; Hamilton-Jacobi theory. Prerequisite: ME 320 or equivalent. LEC.

ME 722. Modeling Dynamics of Mechanical Systems. 3 Hours.
Modeling, analysis and simulation of dynamic mechanical systems. Emphasis on the analysis of kinematics and dynamics of rigid mechanical multibody systems undergoing large overall motion using interactive computer simulation programs. Applications to the design and control of dynamic systems such as robots, machine tools, and artificial limbs. Prerequisite: ME 320 or CE 300. LEC.

ME 733. Gas Dynamics. 3 Hours.
A study of the thermodynamics and fluid dynamics of gaseous media. Emphasis is placed on the rigorous application of conservation laws to represent physical processes. Classical and statistical models for the thermodynamic and transport properties are examined. Applications include determination of gas properties, wave propagation, and high-speed flow. Prerequisite: ME 412 and ME 510 or equivalents. LEC.

ME 736. Catalytic Exhaust Aftertreatment Modeling. 3 Hours.
Fundamental concepts behind catalytic exhaust aftertreatment devices for automobiles including both monolithic catalysts and particulate filters. Studies of other catalytic devices intended for applications in the mechanical and chemical engineering fields. Topics covered are the development of governing equations based on conservation laws and their numerical solutions using finite difference methods. Studies will include a monolithic catalyst. Project assignments will be included. Prerequisite: ME 412 and ME 510 or permission of instructor. LEC.

ME 750. Biomechanics of Human Motion. 3 Hours.
Fundamental concepts of anatomy and physiology are introduced but the focus is on the biomechanics of human motion. Human body segment kinematics and joint kinematics are analyzed. An introduction to muscle

mechanics is provided. Applications in balance and gait are covered. Prerequisite: Corequisite: ME 320 or equivalent. LEC.

ME 751. Experimental Methods in Biomechanics. 3 Hours.
This course will focus on methods of experimental measurement and computational modeling used in biomechanics. Instrumentation used to measure three-dimensional motion, ground reaction forces, center of pressure and EMG measures are considered. Methods used for inverse dynamics, direct dynamics and simulation are introduced. Prerequisite: ME 320 or equivalent. LEC.

ME 752. Acoustics. 3 Hours.
This course will teach the production, propagation, and effects of sound waves. Detailed topics include plane wave, spherical wave, and cylindrical wave propagation in free space and waveguides, wave reflection and transmission on an interface, piston radiation, wave scattering and diffraction. Prerequisite: ME 320 or permission of instructor. LEC.

ME 753. Bone Biomechanics. 3 Hours.
Provides an in-depth knowledge of bone as a living mechanical system. Topics include the microstructure, biology, mechanical properties, mechanical modeling, adaptation of bone to the mechanical environment, and its simulation. Students assignments include homework, a poster presentation, basic finite element analysis laboratory, and bone remodeling simulations. Prerequisite: ME 311 or equivalent. LEC.

ME 754. Biomedical Optics. 3 Hours.
This course will cover the fundamentals of photon transport in biological tissues, including explanations of Rayleigh and Mie scattering, Monte Carlo simulations, the radiative transport equations and more. Also, the basic physics and engineering of various optical imaging techniques for biological tissues, including ballistic or quasi-ballistic imaging (such as confocal microscopy, and optical coherence tomography), diffuse imaging, photoacoustic imaging, will be introduced. Prerequisite: ME 508 or permission of instructor. LEC.

ME 755. Computer Simulation in Biomechanics. 3 Hours.
Provides an in-depth knowledge of 1) the process of developing a research question to be addressed with computer simulation, 2) various techniques for medical imaging to obtain model geometries (including hands-on experience with low-field MR imaging), 3) image segmentation techniques, 4) issues affecting geometric accuracy in model building, 5) the determination and specification of loading and/or kinematic boundary conditions, 6) the interpretation of model results in the context of the model limitations and the medical application. Knowledge and/or experience with finite elements is desirable, but not required. Prerequisite: ME 311 and ME 320 or equivalent. LEC.

ME 756. Biofluid Dynamics. 3 Hours.
An introduction to the fundamentals of biofluid dynamics, and the application of these principles to a variety of biological flows. Fluid flows in physiology, drug delivery, and biotechnology are investigated at a variety of scales, ranging from subcellular to organ groups. Topics include non-Newtonian constitutive equations, solution techniques, and principles of modeling and simulating. Prerequisite: ME 208 and ME 510 or equivalents. LEC.

ME 757. Biomechanical Systems. 3 Hours.
A course on the dynamics and motor control of human and animal motion. The course will focus on applying mechanical principles of dynamics, lumped parameter systems, and control theory to problems in biomechanics. Topics include muscle mechanics and dynamics, reflex and voluntary control, proprioception, anatomy of the muscular and nervous systems, and system dynamics in locomotion and other movements. Prerequisite: ME 682 or permission of instructor. LEC.

ME 758. Physiological System Dynamics. 3 Hours.
This course covers the use of engineering systems modeling approaches to understand the function of physiological systems. Systems covered include the cardiovascular system, the respiratory system, the renal system, the gastrointestinal system, and the musculoskeletal system. Prerequisite: ME 510, ME 320, Physics 212 or permission of instructor. LEC.

ME 760. Biomedical Product Development. 3 Hours.
Introduction to methods of taking medical product inventions from conception to initial stage production. Students work in cross-functional teams to investigate development potential of inventions. Topics covered include product development processes, regulatory issues with the FDA, quality system requirements, SBIR/STTR funding pathways, biomaterial and biomechanics issues in medical product design, and ethical considerations. Prerequisite: Senior or graduate student standing in engineering, business, industrial design, or an applicable life science field and permission of instructor. LEC.

ME 765. Biomaterials. 3 Hours.
An introductory course on biomaterials science and consideration of biomaterials in the design of biomedical implants. Topics including ethical considerations in biomaterials research and the role of the FDA in medical device design are also presented. Prerequisite: ME 306. LEC.

ME 767. Molecular Biomimetics. 3 Hours.
The lessons learned from biological materials are discussed toward developing novel biomimetic materials and systems using environmentally benign processing. Upon completing this course, students will be able to understand the essential features of biological sciences combined with nano- and molecular technologies for next generation bioinspired, biomimetic and bio-enabled materials and systems. Prerequisite: CHEM 130, CHEM 150 or equivalent; introductory course in Material Science (e.g., ME 306.) LEC.

ME 770. Conductive Heat Transfer. 3 Hours.
The formulation of steady- and unsteady-state conduction heat transfer problems and their solution by analytical and numerical methods. Prerequisite: ME 612 or equivalent. LEC.

ME 774. Radiative Heat Transfer. 3 Hours.
The formulation of steady and unsteady radiation heat transfer problems and their solution by analytical and numerical methods. Prerequisite: ME 612 or equivalent. LEC.

ME 788. Optimal Estimation. 3 Hours.
Covers the principles of optimal estimation theory, with particular focus on Kalman filtering and its engineering applications. Prerequisite: A course in elementary linear algebra (e.g.MATH 290), statistics (e.g. MATH 365, MATH 526, or DSCI 202), and system dynamics and control systems (e.g.ME 682.) LEC.

ME 789. Energy Storage Systems and Control. 3 Hours.
This course offers an introduction to the mechanisms, modeling, monitoring and control of energy storage systems with a primary focus on batteries but includes coverage of fuel cells and ultra-capacitors. A major theme is to offer students state-of-the-art knowledge of energy storage systems and aid them in developing the ability to apply estimation and control theory in order to address the problems arising in energy storage management. After completion of the course, a student is expected to: 1) understand the respective work mechanisms, advantages and disadvantages of batteries, fuel cells and ultra-capacitors, 2) understand the mathematical modeling methodologies for batteries, 3) understand the key estimation/control methods and tools, and 4) build effective solutions for energy storage management problems leveraged with estimation/control theory. Prerequisite: ME 682 or equivalent. LEC.

ME 790. Special Topics: _____. 1-5 Hours.
Advanced courses on special topics of current interest in mechanical engineering, given as the need arises. Prerequisite: Approval of instructor. LEC.

ME 797. Materials for Energy Applications. 3 Hours.
Focus on fundamentals of materials for energy applications. The main topics covered will be: 1) introduction to material science engineering and electrochemical technologies, 2) microscopic view of solid materials, 3) mass transfer by migration and diffusion, 4) energy related materials and devices, 5) electrochemical engineering fundamentals, etc. Prerequisite: Basic Engineering Thermodynamics (e.g., ME 312) or equivalent. LEC.

ME 798. Manufacturing for Energy Applications. 3 Hours.
The focus of the course is on fundamentals of materials for energy applications. The main topics covered include: 1) introduction and overview of manufacturing, 2) material properties and engineering materials, 3) traditional and nontraditional manufacturing processes, 4) surface engineering and processing, and 5) energy-related materials and device fabrication. Prerequisite: ME 508 or equivalent and ME 797. LEC.

ME 801. Responsible Conduct of Research in Engineering. 1 Hour.
Lectures and discussion on ethical issues in the conduct of a scientific career, with emphasis on practical topics of special importance in bioengineering. Topics include the nature of ethics, the roles of the scientist as a reviewer, entrepreneur, employer and teacher, research ethics in the laboratory, social responsibility and research ethics regulation. (Same as BIOE 801.) Prerequisite: Permission of instructor. LEC.

ME 808. Advanced Microprocessor Applications. 3 Hours.
Advanced design and development of microprocessor based mechanical systems. Individual and team projects involving the development and integration of hardware and software into a "smart" system which includes the sensing, processing, and controlling functions are accomplished. Emphasis is on the use of the latest sensors and development tools. Prerequisite: Permission of instructor. LEC.

ME 810. Advanced Fluid Mechanics. 3 Hours.
Topics include kinematic and dynamic behavior of fluids, derivation of Navier-Stokes equations, flow classification, solutions of viscous and inviscid flows for simple geometries, potential flow theory and laminar and turbulent boundary layer theory. Prerequisite: ME 510 or equivalent. LEC.

ME 831. Convective Heat and Momentum Transfer. 3 Hours.
The formulation and solution of steady and unsteady convective heat, mass, and momentum transfer problems. Topics include boundary layers, duct flows, natural convection with and without phase change, development of analogies, transport properties, numerical methods. Prerequisite: ME 612 or equivalent. LEC.

ME 832. Computational Fluid Dynamics and Heat Transfer. 3 Hours.
The fundamentals of the finite-difference method are presented and applied to the formulation of numerical models for heat and momentum transfer. The accuracy, stability, and computational efficiency of different algorithms are analyzed. Computer programs are developed for classical benchmark problems. Prerequisite: ME 508, ME 510, and ME 612 or equivalents. LEC.

ME 833. Radiative Heat Transfer. 3 Hours.
The formulation of steady and unsteady radiation heat transfer problems and their solution by analytical and numerical methods. Prerequisite: ME 612 or equivalent. LEC.

ME 836. Hybrid and Electric Vehicles. 3 Hours.
Topics covered include history of electrified vehicles, vehicle modeling, battery chemistry, and electric motors. Review of fundamental electrical engineering concepts provided. Application of real world driving profiles through homework assignments. Laboratories will explore battery and motor fundamentals. Homework assignments will be included along with a semester project involving the design, construction, and testing of a scale electric vehicle. Prerequisite: ME 636 or permission of instructor. LEC.

ME 840. Continuum Mechanics I. 3 Hours.
Principles of Continuum Mechanics for solids, fluids, and gases. Frames of references, measures of motion, deformation, strains, stresses, their rates, objectivity and invariance. Conservation laws, constitutive equations, equations of state and thermodynamic principles for developing mathematical models of continuum matter. Theoretical solutions of model problems. Prerequisite: Background in Calculus and Differential Equations is recommended. LEC.

ME 841. Continuum Mechanics II. 3 Hours.
Fundamental principles of Continuum Plasticity, measures of plastic strains, stresses and constitutive equations for flow theory of plasticity. Internal variable theory of thermo-mechanical behaviors and endochronic theory of plasticity and viscoplasticity. Anisotropic plasticity and advanced topics. Continuum mechanics principles for viscoelastic solids with emphasis on constitutive equations. Development of complete mathematical models and solutions of selected model problems. Prerequisite: ME 840. LEC.

ME 854. Continuum Mechanics for Soft Tissues. 3 Hours.
An introductory course in the analysis of the mechanical behavior of materials modeled on the continuum assumption. The course will provide background on soft tissue properties and will focus on the tools necessary to model soft tissues, including the essential mathematics, stress principles, kinematics of deformation and motion, and viscoelasticity. Prerequisite: ME 311 or equivalent. LEC.

ME 860. Advanced Mechanical Engineering Problems. 1-3 Hours.
An analytical or experimental study of problems or subjects of immediate interest to a student and faculty member and which is intended to develop students capability for independent research or application of engineering science and technology. Maximum credit toward any degree is three hours unless waived in writing by the departmental chairperson. Prerequisite: Approval of instructor. RSH.

ME 861. Theory of the Finite Element Method. 3 Hours.
Finite element method for solid mechanics, heat transfer, fluid mechanics, and dynamics. Modeling techniques, software implementation, and solution of problems. Prerequisite: Background in Calculus and Differential Equations is recommended. LEC.

ME 862. Finite Element Method for Transient Analysis. 3 Hours.
Advanced treatment of dynamic and transient response for linear and nonlinear problems in solid mechanics. Formulation and solution of time dependent linear and nonlinear field problems using finite element techniques. Prerequisite: ME 861. LEC.

ME 864. Mesh Generation and Adaptivity for Finite Element Simulations in Engineering. 3 Hours.
The generation of Finite Element meshes in the analysis and simulation of engineering systems. Important topics are treated such as initial mesh generation and refinements (i.e. geometric modeling and mesh adaptivity or grading), choice of type of element, and assessment of solution accuracy (i.e. error estimation). Assignments include solving problems using FE software. Prerequisite: ME 661, ME 861, or equivalent. LEC.

ME 882. Advanced Control Systems. 3 Hours.
Advanced methods in the modeling, analysis and design of linear and nonlinear control systems. Topics include but not limited to digital controls

methods, energy-based modeling, and state-space methods. Prerequisite: ME 682. LEC.

ME 890. Special Topics: _____. 1-5 Hours.
Advanced courses on special topics of current interest in mechanical engineering, given as the need arises. Prerequisite: Approval of instructor. RSH.

ME 899. Independent Investigation. 1-6 Hours.
An analytical or experimental investigation of an engineering problem requiring independent research. If the thesis option is selected six credit hours are required for the degree. If the project option is selected three credit hours are required for the degree. (See requirements for the Master of Science degree for additional details.) Graded on a satisfactory progress/limited progress/no progress basis. THE.

ME 961. Finite Element Method for Nonlinear Problems in Solid Mechanics. 3 Hours.
Advanced treatment of finite element techniques for structural analysis including material and geometric non-linearity as well as large strain deformation. Prerequisite: ME 861 or equivalent. LEC.

ME 962. p-Approximation, Error Estimation, and Other Advanced Topics in the Finite Element Method. 3 Hours.
Advanced treatment of p-Approximation, error estimation, and other advanced topics in the finite element method. Prerequisite: ME 861 or equivalent. LEC.

ME 965. Mathematical Modeling and Computational Method in Multi-Scale Processes. 3 Hours.
An overview of classical averaging and homogenization methods, as well as current multi-scale modeling techniques for the analysis of the micro- and nano-mechanics of materials. Models and numerical techniques are introduced based on continuum as well as particle descriptions. Assignments include the simulation of micro- and nano-mechanics problems by using existing finite element software and molecular dynamics packages. Prerequisite: ME 861 and ME 840. LEC.

ME 990. Special Topics: _____. 1-5 Hours.
Advanced courses on special topics of current interest in mechanical engineering, given as the need arises. Prerequisite: Approval of instructor. RSH.

ME 999. Independent Investigation. 1-16 Hours.
An analytical or experimental investigation of an engineering problem requiring independent research. Twenty four hours as a minimum are awarded for the Ph.D. dissertation. An original contribution suitable for publication in a referred journal is required of Ph.D. candidates. Graded on a satisfactory progress/limited progress/no progress basis. THE.