Advanced Engineering Technical Electives

Fall 2024

ME 590	Fluid Systems & Gas Dynamics	Pre: ME 510	Dr. Bergman	
ME 590	Intro Scan Electron Microscope	Pre: ME 455	Dr. Liu	
ME 627	Automotive Design	Pre: ME 617	Dr. Sorem	Required for JMS
ME 633	Basic Biomechanics	Pre: ME 311 and ME 320	Dr. Fischer	Required for BIOE
ME 702	Mechanical Engineering Analysis	Pre: MATH 220	Dr. Yang	
ME 712	Adv Engineering Thermodynamics	Pre: ME 212*	Dr. Depcik	
ME 716	Intro to Surface & Interface Science	Pre: ME 212	Dr. Kwon	
ME 722	Modeling Dynamics Mech Systems	Pre: ME 320	Dr. Luchies	
ME 736	Catalytc Exhst Aftertrtmnt Mod	Pre: ME 510	Dr. Depcik	
ME 754	Medical Imaging	Pre: ME 508	Dr. Yang	BIOE
ME 765	Biomaterials	Pre: ME 306	Dr. Tamerler	BIOE
ME 789	Energy Storage Systems & Control	Pre: ME 682	Dr. Fang	
ME 790	Mechanical Metallurgy	Pre: ME 306, ME 311; Co: ME 307	Dr. Pourladian	

* ME 212 grade of C- or better.

Spring 2025

ME 590	Life Cyc Asses for Sust Design	Pre: MATH 365, ME 212, 306, 311	Dr. McVey	
ME 608/708	Intro to Mechatronics / Mechatronics	Pre: ME 208, 320	Dr. Wilson	
ME 696	Design for Manufacturability	Pre: ME 501	Dr. Maletsky	
ME 750	Biomechanics of Human Motion	Pre: ME 320	Dr. Luchies	BIOE
ME 752	Acoustics	Pre: ME 320	Dr. Yang	
ME 753	Bone Mechanics	Pre: ME 311	Dr. Fischer	
ME 760	Biomedical Product Development	Pre: Senior	Dr. Friis	BIOE
ME 790	Advanced Heat & Mass Transfer	Pre: ME 612	Dr. Bergman	
ME 790	Characterization of Materials	Pre: ME 306	Dr. Spencer	
ME 790	Biomedical Microdevices		Dr. Soper	BIOE
ME 790	Machine Learning for Mech Engr	Pre: MATH 121,125, ME 508	Dr. Deng	
ME 797	Materials for Energy Applications	Pre: ME 212*	Dr. Liu	

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ME 590 Fluid Systems & Gas Dynamics

One-third of the course will extend the coverage of ME 510 to include rotating machinery (fans, pumps) and practical fluid-handling issues and fluid-handling systems. The second two-thirds of the course will introduce the basic concepts of compressible fluid flow.

Topics: Reynolds Transport Theorem, Conservation of Mass and Linear Momentum (1 week); Conservation of Angular Momentum (1 week); Fluid Machinery (1 week); Fluid Handling and Pumping Systems (1 week); Thermodynamics and the Velocity of Sound (1 week); Isentropic Flow of Ideal Gases (1 week); Stationary Normal Shocks (1 week); Oblique Shocks (1 week); Prandtl-Meyer Flow and Supersonic Airfoils (1 week); Flow with Friction (1 week); Flow with Heat Transfer (1 week); Flow with Variable Area and Heat Transfer (1 week); In-class Examples and Problems (1.5 weeks); Examinations (1.5 weeks)

Prerequisite: ME 510

ME 590 Intro Scan Electron Microscope

The objectives of this course are to have students continue to develop a systematic approach to problem solving and critical thinking in a series of experiments to learn the techniques hands-on for scanning electron microscopy (SEM), X-ray microanalysis, and analytical electron microscopy. This hands-on course will build on your experiences in physics and chemistry, and measurements.

Topics: Electron Optical Column; Vacuum Systems; System Comparison; Signal Detection and Display; Image Formation and Interpretation of Signals; Analytical X-ray Microanalysis; Practical Things; Other Instruments

Prerequisite: ME 455

ME 627 Automotive Design

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.

Topics: Vehicle Design: Chassis and frame; Suspension and steering; Front and rear axles and power train; Braking and vehicle dynamic performance; Design Project: Engineering specifications; Project scheduling; Concept generation and evaluation; Performance evaluation; Design for manufacture, assembly and implementation; Analysis (stress, thermal, economic, environmental, etc.)

Prerequisite: ME 617

ME 633 Basic Biomechanics

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 ME 311.

Topics: Brief History of Biomechanics (1 week); Cellular Biomechanics (3 weeks); Tissue Biomechanics (5 weeks); Orthopedic pathologies, treatments, implants, and FDA considerations (2 weeks); Basic Dynamics applied to Human Motion (2 weeks); Cardiovascular Biomechanics (3 weeks); Extracellular Matrix Biomechanics (1 week)

Prerequisite: ME 311 and ME 320

ME 702 Mechanical Engineering Analysis

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.

Topics: ODE review (1 week); Laplace transform techniques (2 weeks); Partial differential equations (analytical and [numerical, time permitting] solutions) (3 weeks); Eigenvalue problems (2 weeks); Matrices and vectors (1 week); Fourier transforms (1 week); Complex numbers, integration, residues (3 weeks); R^3 space and vector calculus (time permitting); Examinations and special topics (1-2 weeks)

Prerequisite: MATH 220

ME 712 Adv Engineering Thermodynamics

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.

Topics: Review of basic thermodynamics (1 week); Reacting systems and chemical equilibrium (2 weeks); Thermodynamic relationships and real gas models (2 weeks); Exergy (2 weeks); One-dimensional gas flow and compressibility (3 weeks); Special thermodynamic systems (2 weeks); Examinations and special topics (2 weeks)
Prerequisite: ME 212 (grade C- or better)

ME 716 Intro to Surface & Interface Science
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 self-cleaning mechanisms, anti-reflective coating, fog harvesting and de-icing.
Topics: Theory of capillarity, and the equation of Young and Laplace (2 weeks); Surface and interfacial energy and kinetics of wetting (2 weeks); Thermodynamics of interfaces and Gibbs free energy (2 weeks); Adsorption and Langmuir isotherm (2 weeks); Surface modification and characterization (2 weeks); Electrowetting and electric double layer (1 week); Recent development of bio-inspired surfaces with special wettability (4 weeks)
Prerequisite: ME 212 or physical chemistry or equivalent.

ME 722 Modeling Dynamics Mech Systems
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.
Topics: Modeling and Simulation Techniques (2 weeks); Foundations (3 weeks): Virtual prototyping process, parts, initial conditions, constraints, rotation, joints, measures, forces, moments, torques, bushings, impact, scripts, solver, sensors, quiver plots, splines, and design studies; Applications (6 weeks): Falling stone, inclined plane, lift mechanism, pendulum, projectile motion, spring damper, suspension system, four bar linkage, cam-follower, crank slider, controls, valve-train, cam-rocker-valve, stamping mechanism, robot arm, optimization, and airplane control surface; Term Project (3 weeks); Examinations (1 weeks)
Prerequisite: ME 320

ME 736 Catalytic Exhst Aftertrtmnt Mod
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.
Topics: Primary pollutants, secondary pollutants, greenhouse gases, and regulatory efforts (2 weeks); Introduction to catalytic aftertreatment devices and particulate filters (2 weeks); Fundamentals of chemistry including chemical bonds, chemical kinetics, reaction rates, surface adsorption, equilibrium, and detailed and global reactions (3 weeks); Derivation of the differential versions of the conservation of mass, momentum, energy, entropy, and species, including simplifications and extensions (3 weeks); One-dimensional and one+one-dimensional monolithic catalyst modeling, dynamically incompressible and compressible versions (2 weeks); Student presentations (2 weeks)
Prerequisite: ME 212 with a grade of C- or better and ME 510

ME 754 Medical Imaging
This course will focus on the fundamental physics of modern medical imaging technologies, which includes X-Ray, Computed Tomography, Magnetic Resonance Imaging, ultrasound imaging, optical imaging, and more. Recent trends in medical imaging technology development will also be introduced.
Topics: Background of biomedical optics (1 week); Single scattering (1 week); Monte Carlo modeling (4 weeks); Convolution for broad-beam response (1 week); Radiative transfer equation and diffusion theory (2 weeks); Hydride model of Monte Carlo method and diffusion theory (1 week); Sensing of optical properties and spectroscopy (1 week); Ballistic imaging and microscopy (1 week); Diffuse optical tomography (1 week); Photoacoustic imaging (1 week); Examination (1 week)
Prerequisite: ME 508

ME 765 Biomaterials
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.

Topics: Technical Writing (2 weeks); Economic Analysis (0.5 week); Ethics (0.5 week); Research Design (3 weeks); Regulatory (0.5 week); Biomaterials (7 weeks); Oral Communication (0.5 week); Examinations (1 week)
Prerequisite: ME 306

ME 789 Energy Storage Systems & Control
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.
Topics: 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

ME 790 Mechanical Metallurgy
This course will present an area of knowledge which deals with the behavior and response of metals to applied forces. This knowledge will be presented in four parts: 1) Mechanical fundamentals; 2) Metallurgical fundamentals; 3) Applications in materials testing; 4) Plastic forming of metals.
Topics: Mechanical Fundamentals such as stress and strain relationships for elastic behavior and an introduction to elements of the theory of plasticity (2 weeks); Metallurgical Fundamentals such as plastic deformation, dislocation theory, strengthening mechanisms, fracture (3 weeks); Applications in materials testing such as Tension Test, Torsion Test, Hardness Test, Fracture Mechanics, Fatigue, Brittle fracture and impact testing (3 weeks); Plastic forming of metals such as Fundamental of metalworking, Forging, Rolling of metals, Drawing of rods, wires and tubes, Sheet-Metal forming (3 weeks); Literature reviews and case studies (3 weeks); Exams (1 week).
Prerequisite: ME 306 and ME 311; Corequisite: ME 307

Spring 2025

ME 590 Life Cyc Asses for Sust Design
Introduction to and application of environmental life cycle assessment as a quantitative tool for sustainable engineering design, with a focus on whole-building and MEP applications.
Prerequisite: MATH 365, ME 212, ME 306, and ME 311

ME 608/708 Intro to Mechatronics / Mechatronics
Undergrads should enroll to ME 608. Graduate students should enroll to ME 708. If you are an undergraduate who would like to take ME 708 instead for an honors class, please email Dr. Wilson for permission. sewilson@ku.edu
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.
Topics: C++ programming of microcontrollers (4 weeks); Sensors and actuators (3 weeks); Robotic system integration and programming (3 weeks); Modeling and design of mechatronic systems (3 weeks); Individual projects (2 weeks)
Prerequisite: ME 208 and ME 320

ME 696 Design for Manufacturability
Tools to incorporate manufacturing and life-cycle concerns into the design of products.
Topics: Design process and concurrent engineering (2 weeks); Quality function deployment (1 week); Embodiment and parametric design (1 week); Modeling and prototyping (1 week); Manufacturing process in design (1 weeks); Design for assembly (1 week); Quality engineering (SPC) (2 weeks); Statistics and statistical tolerancing (2 weeks); Design of experiments (Taguchi method) (1 week); Current topics related to manufacturing and engineering (2 weeks); Examinations (1 week)
Prerequisite: ME 501

ME 750 Biomechanics of Human Motion
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.
Topics: Introduction to Musculoskeletal Modeling and Analysis (1 week); Defining Skeletal Kinematics (10 weeks); Dynamic Equations of Motion (Kane's Method) (4 weeks)
Prerequisite: ME 320

ME 752 Acoustics
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.
Topics: Wave equation (1 week); Plane waves (1 week); Reflection and transmission (3 weeks); Waveguides (1 week); Absorption and dispersion (1 week); Spherical waves (2 weeks); Cylindrical waves (1 week); Radiation (2 weeks); Scattering and diffraction (1 week); Examination and special talk (3 weeks)
Prerequisite: ME 320

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

ME 760 Biomedical Product Development
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.
Topics: Technical Writing (2 weeks); Economic Analysis (2 weeks); Ethics (1 week); Research Design (3.5 weeks) Intellectual Property (1 week); Regulatory (1 week); Quality Systems (1 week); Product Design (2 weeks); Biomaterials and Biomechanics (1 week); Examinations (0.5 weeks)
Prerequisite: Senior or graduate student standing in engineering, business, industrial design, or an applicable life science field.

ME 790 Advanced Heat and Mass Transfer
Conduction, convection, and radiation are covered in more detail relative to ME 612, with a focus on the underlying physical phenomena and associated mathematical analyses. Diffusive and convective mass transfer is a significant part of this class, with emphasis on the analogies between conduction heat transfer and diffusive mass transfer, as well as convection heat transfer and convection mass transfer.
Prerequisite: ME 612

ME 790 Characterization of Materials
Principles and application of current techniques for structural, morphological, physical, and mechanical property characterization of a range of materials including polymers, composites, ceramics, tissues, wood, metals and metallic alloys. Particular attention will be on the characterization of interfaces that form when dissimilar materials are joined, such as fiber/matrix etc. The course will explore the fundamental connections between materials structure and physical properties at length scales from the sub-micron to fractions of meters. Techniques studied include vibrational spectroscopies, thermal analysis, chromatographic techniques, x-ray diffraction, atomic force microscopy, electron microscopies, XPS, and X-ray tomography. Examples from various industries and fields of materials research will illustrate the application and significance of these techniques.
Prerequisite: ME 306

ME 797 Materials for Energy Applications
Focus on fundamentals of materials for energy applications.
Topics: Introduction to material science & engineering and electrochemical technologies; microscopic view of solid materials; mass transfer by migration and diffusion; energy related materials and devices; electrochemical engineering fundamentals
Prerequisite: ME 212