MECHANICAL ENGINEERING

A candidate for the Master of Science in Engineering (Mechanical Engineering) must meet the requirements for the Bachelor of Science in Engineering (Mechanical Engineering) degree at this campus or the essential equivalent to these requirements. The candidate must then complete at least 30 credit hours of graduate work approved by the program advisor/graduate committee with an average grade of at least *B* (3.0) covering all courses elected. These 30 credit hours must include one graduate-level cognate course for a minimum of three credit hours in a department other than mechanical engineering, with the option to take a second non-ME cognate in an engineering field. Students are not permitted to elect more than two courses outside mechanical engineering.

Students who have not fulfilled the requirements of the bachelor's degree in mechanical engineering should communicate with the department graduate committee regarding the requirements to be met.

Accelerated Master's options for Mechanical Engineering Students

The accelerated undergraduate/master's studies option in mechanical engineering or bioengineering (4+1 options) allows the most qualified UM-Dearborn undergraduate mechanical engineering students to pursue a program of study in which BSE (ME) and MSE (ME or BENG) degrees are earned in a five-year accelerated format. This is achieved via combining a portion of undergraduate and graduate coursework. Students admitted to the ME 4+1 Option can double-count up to 9 credits of 500-level or above mechanical engineering elective courses taken during their junior or senior years. Students admitted to the BENG 4+1 Option can double-count up to 9 credits of 500-level or above bioengineering core, elective, or cognate courses taken during their junior or senior years. Of these, only one cognate course is allowed. In practice with the usual graduate student program rules, 4+1 students may also transfer a maximum of 6 additional 500 level credits toward the 30-credit master's degree. These additional transfer credits can be taken during the junior and senior years and cannot be used for any portion of the undergraduate degree. Depending on the number of double-counted and transfer credits, 15-21 credits of graduate coursework would be needed to complete the master's program after completion of the undergraduate degree.

Please see the Mechanical Engineering 4+1 Option webpage for more information.

Program Requirements

Code	Title	Credit Hours
Area I: Required course		
ME 518	Advanced Engineering Analysis [1]	3
Area II: ME Elective Courses (7-8 courses)		**24**
ME 510	Finite Element Methods [3]	
ME 512	Structural Dynamics	
ME 513	Advanced Biomechanics	
ME 514	Advanced Mechanics of Materials	
ME 516	Special Topics in Mech Eng	
ME 521	Dynamics and Thermodynamics of Compressible Flow	
ME 522	Advanced Fluid Mechanics	
ME 523	Sustainability Science and Engineering	
ME 525	Computational Fluid Mechanics and Heat Transfer [3]	
ME 526	Microfluidics	
ME 528	Fund of Boiling and Condensatn	
ME 531	Statistical Thermodynamics	
ME 532	Combustion Processes	
ME 535	Advanced Thermodynamics	
ME 538/ AENG 566	Vehicle Thermal Management	
ME 540	Mechanical Vibrations	
ME 542	Advanced Dynamics	
ME 543	Vehicle Dynamics	
ME 545	Acoustics and Noise Control	
ME/AENG 547	Automotive Powertrains I	
ME 548	Automotive Powertrains II	
ME 552/ ESE 500	Sustainable Energy Systems	
ME 553	Structural Design and CAE Analysis for Electric Vehicle Batteries	
ME 555	Computational Uncertainty Quantification for Engineering Applications [3]	
ME 556	Stress and Strength Considerations in Design	
ME 558	Fracture and Fatigue Considerations in Design	
ME 559	Battery Materials, Manufacturing and Recycling	
ME 560	Experimental Methods in Design	
ME 562	Energy Management of Electrified Vehicles	
ME 564	Linear Systems Control [3]	
ME 565/ ECE 566	Mechatronics	
ME 566/ MTSE 501	Materials Thermodynamics and Kinetics	
ME 568	Computational Materials Design	
ME 569/ MTSE 502	Introduction to Materials Characterization	
ME 570	Powertrain NVH of Electrified Vehicles	
ME 576	Battery Sys Modeling & Ctrl	
ME 577/ ESE 501	Energy Conversion	
ME 578	Advanced Vehicle Energy Systems	
ME 580	Advanced Engineering Materials	
ME 582	Injection Molding	
ME 583	Mechanical Behavior of Materials	
ME 585	Cast Metals in Engineering Design	
ME 586	Materials Consideration in Manufacturing	
ME 589	Composite Materials	
ME 591	Degradation of Materials [3]	
ME 592	Fundamentals of Fuel Cells	
ME 593	Powder Materials & Processing	
ME/BENG 595	Digital Manufacturing [3]	
ME/AENG 596	Internal Combustion Engines I [3]	
ME 597	Internal Combustion Engines II	
ME 598	Engine Emissions	

ME 610	Finite Element Methods--Nonlinear	
ME 611	Modeling of Engineering Materials	
ME 622	Advanced Topics in Fluid Mechanics	
ME 675	Predictive Control of Dynamic Systems	
Area III: Cognates (1-2 500 level courses)		**3-6**
Required: One non-mechanical engineering course (any 500-level non-ME course, excluding ENGR 500 and ENGR 501)		
Optional: One additional non-ME cognate (CECS courses only, excluding ENGR 500, ENGR 501, and certain EMGT and IMSE courses) [2]		
Area IV: Thesis and Independent Study		
Optional - credit hours to be deducted from Area II ME Elective Courses		
ME 600	Study or Research in Selected Mechanical Engineering Topics	
ME 601	Experimental Research in Mechanical Engineering	
ME 602	Guided Graduate Study in Mechanical Engineering	
ME 699	Master's Thesis	
Total credits required:		**30**

1 Must be taken within the first two terms of enrollment.

2 Optional: An additional non-mechanical engineering course (any 500-level non-ME course in an engineering discipline, excluding the following courses: **EMGT** 500, 505, 510, 515, 530, 535, 541, 545, 550, 560, 570, 580; **IMSE** 5010, 515, 516, 517, 520, 5275, 5655, 570, 579); credits will be taken from the ME electives area

3 Simultaneous credit toward the BSE Mechanical Engineering major and MSE Mechanical Engineering for students admitted to the 4+1 option. Please see the College's website for admission requirements and program details.

Students must earn a C or better in every graduate course to be credited toward the degree requirements. In addition, students must maintain a cumulative GPA of 3.0 or higher.

In order to be admitted as an applicant for the master's degree, students must satisfy the graduate committee of the department that they have completed preparation equivalent to the undergraduate degree requirements in this department and that they are prepared to undertake the advanced courses. In general, the applicants must have maintained *B* averages as undergraduates. Students will not be given graduate credit for courses equivalent to any which they have been required to take for the bachelor's degree or for courses required in the undergraduate curriculum of this department.

Learning Goals

1. Students will be able to demonstrate ability to use the latest technologies in the mechanical engineering field.
2. Students will be able to formulate, analyze, and solve advanced mechanical engineering problems.
3. Students will be able to apply the latest scientific and technological advancements, advanced techniques, and modern engineering tools in their professional endeavors.

ME 510 Finite Element Methods 3 Credit Hours
Overview and applications of FE theory in linear static and dynamic systems. Review of matrices, strain and stress tensors. Variational and energy principles in FEA. Applications in linear stress analysis; 1D, 2D and 3D. Transient solutions; modal analysis. Modeling concepts. Use of general purpose codes like ANSYS, NISA, ARIES. Project work. Graduate standing or special permission. (YR).
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is Mechanical Engineering-NCFD, , Bioengineering, Mechanical Engineering

ME 512 Structural Dynamics 3 Credit Hours
Advanced treatment of dynamic structural theories. Topics covered include: Rayleigh and Timoshenko beams and plates; free and forced vibration response of structural components; static and dynamic stability; and impact.
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 513 Advanced Biomechanics 3 Credit Hours
This course covers intermediate level subject matter on structural biomechanics, analysis and design. Topics include: soft tissues biomechanics, human motion analysis including gait, orthopedic implants, fixation and reconstruction, head impact and injury, and advanced bone models. (YR) (YR).
Restriction(s):
Can enroll if Level is Doctorate or Rackham or Graduate or
Can enroll if Major is , Mechanical Engineering

ME 514 Advanced Mechanics of Materials 3 Credit Hours
Stresses and deformations in mechanical and structural elements and systems; theory, analysis and applications. Topics selected from among the following in applied elasticity and advanced mechanics of materials: stress and strain transformation; plane theory of elasticity and stress functions; energy methods; thick-walled cylinders and spinning disks; torsion of non-circular and hollow sections; unsymmetric bending and shear center; curved beams; beams on elastic foundations; plates and shells; elastic stability. Graduate standing or permission of instructor. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 516 Special Topics in Mech Eng 1 to 3 Credit Hours
Selected topics pertinent to mechanical engineering. Graduate standing or special permission. (YR).
Restriction(s):
Cannot enroll if Class is
Cannot enroll if Level is
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 518 Advanced Engineering Analysis 3 Credit Hours
The course emphasizes the exact methods used in the solution of the partial differential equations that arise in advanced engineering problems. Examples are taken from heat transfer, fluid dynamics, solid mechanics, electromagnetic theory, vibrations, etc. Linear integral equations, time dependent boundary conditions, nonlinear boundary conditions, and other topics. Graduate standing or special permission. (YR).
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is Mechanical Engineering-NCFD, , Bioengineering, Mechanical Engineering

ME 521 Dyn and Therm of Comp Flow 3 Credit Hours
Review of basic equations of fluid mechanics and thermodynamics in control volume form. One-dimensional, compressible flow involving area change, normal shocks, friction, heat transfer, and combined effects. Two-dimensional supersonic flow including linearization, method of characteristics, and oblique shocks. One-dimensional, constant area, unsteady flow. Graduate standing or special permission. (YR).
Restriction(s):
Cannot enroll if Level is
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 522 Advanced Fluid Mechanics 3 Credit Hours
Graduate level course of fluid mechanics. Review of fluid flow phenomena based on common principles of transfer of mass, momentum, and energy. Introduction of the fundamental concepts and methods of analysis of fluid flows in industrial and environmental settings. Navier Stokes equations; viscous and inviscid flows; laminar and turbulent flows; boundary layers; drag; thermal convection. Prerequisite: Full course of undergraduate thermodynamics, fluid dynamics, and heat transfer. Course is the equivalent of ME 520. Students who have already taken ME 520 with a grade of B or better will not receive additional credit for ME 522. (OC).
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is Mechanical Engineering-NCFD, , Bioengineering, Mechanical Engineering

ME 523 Sustainability Science and Engineering 3 Credit Hours
Sustainable development is commonly defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This course incorporates ethical and social issues into the design of products, processes and practices that will benefit the society as a whole. Specific emphasis will be given to engineering principles that will help engineers design products and services to meet societal needs with minimal impact on the global ecosystem. Using specific examples and illustrations, the course will demonstrate opportunities for sustainable engineering practices, providing students with valuable insight to applying these principles. Further, students will debate and evaluate biased and controversial opinions published in various media channels. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering, Automotive Systems Engineering, Bioengineering

ME 525 Computational Fluid Mechanics and Heat Transfer 3 Credit Hours
The course introduces students to the fundamentals of computational fluid dynamics and heat transfer. Classification of partial differential equations and formulation of well-posed problems. Spatial and temporal approximation techniques for partial differential equations: stability, consistency and convergence. Finite volume formulations. Survey of methods for solving hyperbolic, elliptic, and parabolic problems. Formulation of discrete boundary conditions. Application of methods to one- and two-dimensional flow and heat transfer problems. (AY).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is Mechanical Engineering-NCFD, , Bioengineering, Mechanical Engineering

ME 526 Microfluidics 3 Credit Hours
Microscaled systems and devices have enhanced reaction rates, predictable fluid mechanics, reduced reagent volumes, and a cheaper path to rapid prototyping. These advantages benefit many biomedical and processes engineering applications that require sensitive molecular detection and precise flow controls. In this course, a range of microsystem techniques will be discussed, including those based on microfluidics, MEMS, and optofluidics. The lectures will be accompanied by student-driven design projects that will be conducted in 3-hour laboratories. (YR).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering

ME 530 Modeling of Automotive Systems 3 Credit Hours
This course will first introduce systems modeling approach and then develop mathematical models for ride, vibration, handling control, etc. of automobiles. The models will then be used to examine the design and performance of an automobile from a systems point of view. (YR).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering

ME 532 Combustion Processes 3 Credit Hours
Introduction to combustion processes, equilibrium and reaction kinetics. Combustion of premixed gases, detonation and deflagration flames. Laminar and turbulent flames. Ignition, flammability, and flame quenching. Application to spark, diesel and gas turbine engines. Combustion-generated pollution. Graduate standing or special permission. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 535 Advanced Thermodynamics 3 Credit Hours
Advanced treatment of engineering thermodynamics as applied to producing mechanical power and refrigeration. Involves rigorous application of the first and second laws. Topics to be discussed are energy/entropy generation, thermodynamics relations, nonreacting mixtures, and reacting mixtures. Graduate standing or special permission. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 538 Vehicle Thermal Management 3 Credit Hours
This course covers fundamental thermo-fluid principles and advanced topics in thermal management of conventional and electric drive vehicles (EDVs). The topics include: principles of energy conservation, heat transfer, and fluid mechanics; vehicle thermal management system and components; electrification of vehicle thermal management system; EDV thermal management; battery thermal management in EDVs; and waste energy recovery.
Restriction(s):
Cannot enroll if Class is
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 540 Mechanical Vibrations 3 Credit Hours
A study of the linear vibrations of discrete multi-degree-of-freedom systems. Generation of equations of motion using the unit displacement, unit force, and Lagrange methods. Generalized eigenvalue problem. Modal analysis. Effects of damping. Synthesis of forced response by the unit step, unit impulse, and Fourier series methods; response to shock excitation. Numerical techniques. Graduate standing or special permission. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is Mechanical Engineering-NCFD, , Bioengineering, Mechanical Engineering

ME 542 Advanced Dynamics 3 Credit Hours
An advanced treatment of analytical mechanics for particles, systems of particles and rigid body motions with special emphasis on three-dimensional motion. Lagrange's equation of motion will be introduced and utilized in the analysis of multiple-mass systems. Computer methods will be covered. Graduate standing or special permission. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is Mechanical Engineering-NCFD, , Bioengineering, Mechanical Engineering

ME 543 Vehicle Dynamics 3 Credit Hours
A treatment of the response, ride, and maneuvering of motor vehicles. Road loads, suspension systems, mechanics of pneumatic tires. (YR).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 545 Acoustics and Noise Control 3 Credit Hours
Fundamentals of acoustical waves, sound propagation and intensity, instruments for vibration and noise, HVAC system noise, automobile and aircraft noise, noise control techniques. Graduate standing or special permission. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 547 Powertrains I 3 Credit Hours
Topics in vehicle powertrain kinematics and dynamics, engine output characteristics, vehicle road load analysis, engine-transmission matching, design and analysis of gears and gear systems, planetary gear trains, design of powertrain components, clutch design and analysis, transmission design and analysis, torque and ratio analysis of automatic transmissions. (YR).
Restriction(s):
Cannot enroll if Class is
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 548 Automotive Powertrains II 3 Credit Hours
Simulation of vehicle performance; dynamics in gear shifting; engine balance, fuel economy, and performance related to powertrains; powertrain arrangements, manual and automatic transmissions, automotive axles, four-wheel-drive systems; design and manufacturing of gearing systems.
Prerequisite(s): AENG 547 or ME 547
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 549 Mechanical Wave Vibrations 3 Credit Hours
Vibrations in distributed systems are analyzed using a novel wave based approach, in which vibrations are described as waves propagating along a structural waveguide. Such waves are reflected and transmitted when incident upon structural discontinuities. The propagation, reflection, and transmission relations are assembled in solving vibration problems in distributed mechanical structures. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering

ME 552 Sustainable Energy Systems 3 Credit Hours
The course provides an overview of energy technology from a broad perspective that encompasses technical and environmental aspects. It covers a wide range of traditional and alternative energy sources and presents assessments of their availability, sustainability, and environmental impacts as well as evaluation of their potential role in solving the global energy problem. Course work includes project.
Restriction(s):
Can enroll if Class is Graduate
Can enroll if Level is Rackham or Graduate
Can enroll if College is Engineering and Computer Science
Cannot enroll if Major is

ME 553 Structural Design and CAE Analysis for Electric Vehicle Batteries 3 Credit Hours
The course aim is to provide the knowledge on Electric Vehicle (EV) battery structural design, development, and validation using CAE analysis. Discussion is centered on the intertwined relationship between EV and batteries during the entire phase of their design, development, and validation. Topics include the discussion on structural analysis for battery module/pack and cells as well as battery components, module/pack sizing, PSD profile development for shaker table, shaker table analysis, and thermal cyclic analysis. Battery manufacturing variations are discussed as well. Finite element techniques for batteries in vehicle validation are also covered. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering

ME 555 Computational Uncertainty Quantification for Engineering Applications 3 Credit Hours
This course focuses on a probabilistic (Bayesian) treatment of uncertainties in modeling a system's behavior, specifically adapted to mechanical engineering and bioengineering problems. This treatment extends to both making predictions under uncertainty (predictive modeling) as well as updating our knowledge about the system model using data/measurements (Bayesian inference). The course will emphasize both (i) applications with physical models as well as (ii) applications with statistical models build entirely based on data/inference. The course will start by briefly reviewing the foundations of probability as a multi-valued logic that quantifies all our available knowledge about a real system and its environment. This leads to a rigorous meaning for the probabilistic model for a system. The main part of the course focuses on computational tools for (i) predictive analysis (i.e., uncertainty propagation) and (b) Bayesian system estimation/identification (i.e., model updating based on experimental observations). (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Bioengineering, Mechanical Engineering

ME 556 Stress and Strength Considerations in Design 3 Credit Hours
Treatment of stress and strength aspects of machine design. Analytic and experimental determination of stresses in machine members. Evaluation of strength under steady and fatigue loadings. Post-yield behavior, residual stress, temperature and corrosion effects. Graduate standing or special permission. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 558 Fracture and Fatigue Considerations in Design 3 Credit Hours
A comprehensive review of fracture and fatigue processes in engineering material with emphasis on mechanics instead of mechanisms of failure. Design methodology based on fracture toughness and fatigue crack propagation is presented. Laboratory test methods and data interpretations are also presented. Graduate standing or permission of instructor. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 559 Battery Materials, Manufacturing and Recycling 3 Credit Hours
This course will provide a comprehensive review of electrode and electrolyte materials used in batteries and their relationship with the battery energy density, power density, voltage, etc. Various manufacturing methods of electrodes and electrolytes and their pros and cons in terms of manufacturing cost, energy, speed, scalability, and environmental impact will be presented. Battery cell types and the structures and materials of battery modules and packs will be introduced. How to calculate module and pack-level energy density and other characteristics will be presented. Finally, various battery recycling methods will be presented. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering, Manufacturing System Engin, Automotive Systems Engineering, Industrial & Systems Engin

ME 562 Energy Management of Electrified Vehicles 3 Credit Hours
This course covers the longitudinal dynamics of electrified vehicles and optimization of energy consumption. Mathematical models are developed for analyzing the energy consumption of vehicle systems. Fundamentals of optimization and optimal control are studied for developing energy management strategies for energy-efficient ground vehicle propulsion. The topics include: vehicle longitudinal dynamics, modeling powertrain components, optimization and optimal control. (OC).
Restriction(s):
Can enroll if Level is Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering

ME 564 Linear Systems Control 3 Credit Hours
This course covers fundamental properties of linear dynamic systems. Topics include linear space, linear operators, Eigen-values/vectors, canonical form, representation, solution of state equations, stability, controllability, observability, design of state feedback control and development of observers with application examples in mechanical engineering. (OC)
Restriction(s):
Can enroll if Level is Doctorate or Rackham or Graduate or
Can enroll if Major is , Mechanical Engineering

ME 565 Mechatronics 3 Credit Hours
Mechatronics, as an engineering discipline, is the synergistic combination of mechanical engineering, electrical engineering, control engineering, and computer science, all integrated through the design process. The course is to establish a working familiarity with the key engineering elements in the design and control of electro-mechanical systems in general and automotive systems in particular. The key engineering elements include microprocessor technology, electronics, sensors and actuators, data communication and interface, control algorithms, and mechanisms of machine elements. The course is to introduce a design methodology in an integrated system environment through case studies and design projects. (OC).
Restriction(s):
Can enroll if Class is Graduate or Doctorate
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering

ME 566 Materials Thermodynamics and Kinetics 3 Credit Hours
A lecture course that provides an understanding of thermodynamics and kinetics in materials and materials processing. Students will develop skills to evaluate the stability of materials under various external conditions, design processes to produce desired materials structures (microstructure and nanostructure), and predict the evolution of materials structures under different operating conditions. Topics will include laws of thermodynamics, equilibrium of single and multiphase systems, chemical thermodynamics, statistical thermodynamics of solid-solutions, equilibrium phase diagrams (unary, binary, and ternary), chemical kinetics, diffusion in solids, nucleation and growth processes, coarsening, glass transition, and phase transformations. Students will be exposed to various software commonly used in industries to evaluate materials thermodynamics and kinetics: Thermo-Calc, CALPHAD, and JMatPro. (YR).
Restriction(s):
Can enroll if Level is Doctorate or Rackham or Graduate or
Can enroll if Major is , Mechanical Engineering

ME 568 Computational Materials Design 3 Credit Hours
The course introduces the fundamentals of modeling and simulations in materials engineering. It covers atomic scale molecular dynamics simulations, mesoscale phase-field simulations, and data-driven machine learning modeling. Software tools including LAMMPS (Large-scale Atomic/Molecular Massively Parallel Simulator), VMD (Visual Molecular Dynamics), MATLAB, and ParaView will be introduced. Students are expected to develop models across different scales, run programs, and analyze the results. (YR).
Restriction(s):
Can enroll if Level is Doctorate or Rackham or Graduate or
Can enroll if Major is , Mechanical Engineering

ME 569 Introduction to Materials Characterization 3 Credit Hours
Designed for graduate students to gain an in-depth understanding of principal methods in materials characterization and analysis. This course will survey bulk as well as nanoscale structural characterization, such as identity, chemical composition and hierarchical arrangement. Analysis techniques such as optical microscopy, X-ray diffraction, electron microscopy, scanning probes and spectroscopy will all be reviewed. Students will learn principles of image formation and interpretation, resolution, contrast and chemical analysis. Focuses on fundamental concepts of different methods as well as practical applications.
The intent is to allow the student to make an educated selection of characterization techniques, or critical analysis of data, for materials and defect analysis. (YR).
Restriction(s):
Can enroll if Level is Doctorate or Rackham or Graduate or
Can enroll if Major is , Mechanical Engineering

ME 570 Powertrain NVH of Electrified Vehicles 3 Credit Hours
This course focuses on the Noise, Vibration and Harshness (NVH) characteristics of Electric Vehicles (EV), Hybrid Electrical Vehicles (HEV), and Plug-In Electric Vehicles (PHEV). Topics include principles of mechanical vibration and acoustics, driveline induced noise/vibration from both conventional internal combustion engine and electrical motor/generator, cooling fan noise, regenerative braking system and electrical accessory noise. The potential countermeasures for typical noise/vibration sources will be presented. The course consists of classroom lectures and experimental laboratory sessions. The laboratory sessions will provide the student with hands-on experience on noise/vibration measurements and analyses. The student will be required to carry out a course project on NVH related subject of electrified vehicles. (YR).
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 574 Advanced Heat Transfer 3 Credit Hours
The course is a comprehensive graduate-level introduction into three modes of heat transfer: conduction, convection, and radiation. Topics include principles, governing equations, and applications of heat transfer; multidimensional steady-state and unsteady heat conduction; forced and natural heat convection in external and internal flows; analysis and design of heat exchangers; fundamentals and analysis of radiative heat transfer; methods of computational solution of heat transfer problems; applications to engineering problems. (OC).
Restriction(s):
Can enroll if Level is Doctorate or Rackham or Graduate or
Can enroll if Major is , Mechanical Engineering

ME 576 Battery Sys Modeling & Ctrl 3 Credit Hours
Full Course Title: Battery Systems, Modeling, and Control This course will cover modeling, control, and estimation techniques for battery systems. Students will learn how electrochemical systems work and how they can be mathematically described. A simple phenomenological electrical circuit model and a detailed physics-based model that can capture diffusion dynamics will be covered. The thermal behavior of a battery system and its modeling will be covered as well. Students will learn the basic functions of battery management systems for monitoring state-of-charge, state-of-power, and state-of-health in applications to automotive and consumer electronics. (OC).
Restriction(s):
Can enroll if Level is Graduate or Rackham or Doctorate
Can enroll if Major is , Automotive Systems Engineering

ME 577 Energy Conversion 3 Credit Hours
This course covers fundamental engineering principles for converting available energy sources, renewable and nonrenewable, into other energy forms of direct utility. It may include such topics as steam and gas based power plants as well as devices for solar, wind, and hydraulic energy conversion.
Restriction(s):
Cannot enroll if Class is
Cannot enroll if Level is
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 578 Advanced Vehicle Energy Systems 3 Credit Hours
Sustainability is an increasingly important topic for the automotive industry. This course discusses sustainable vehicle technology with focus on energy-related aspects, such as resources, consumption, environmental impacts, and regulations. It reviews sustainable technologies employed in automotive systems to reduce emissions in an energy-efficient manner and discusses their impacts on the industry. The course covers the fundamentals, characteristics, and design considerations of the vehicle energy systems. Students have a hands-on practice using numerical simulation tools. Specific technical topics include advanced internal combustion engines, alternative fuels with the focus on biofuels, hybrid, electric, and fuel cell vehicles, waste energy recovery systems, and smart grid system. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is Mechanical Engineering

ME 580 Advanced Engineering Materials 3 Credit Hours
A second course in materials which expands the philosophy that all materials possess common traits which allow: (1) interchange of classes of materials to perform the same function, e.g., metals, polymers, ceramics, composites, etc.; and (2) understanding of the mechanisms of property controls in new materials. There is an attempt to provide equal representation of the science and the phenomena of engineering materials. Greater emphasis is placed on thermodynamics, stress-strain relations, multicomponent phase equilibria, and such other areas as received minimal exposure in the first course in materials. As a result of present technology trends, more time is spent on composites and achievement of design specifications through synthesis. Graduate standing or special permission. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 582 Injection Molding 3 Credit Hours
This is an in-depth course on injection molding processes, which include the conventional injection molding process, low pressure injection molding, structural sandwich molding, gas assisted injection molding etc. Material, process and tool design parameters are emphasized. The roles of rheology and flow modeling are discussed. Design issues for injection molded products are also discussed. Injection molding applied to other materials, such as ceramics, is also described. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 583 Mechanical Behavior of Materials 3 Credit Hours
Mechanical behavior of materials are covered in relation to their structures, deformation characteristics and failure mechanisms. Means of improving strength, fracture toughness and other mechanical properties are discussed. Environmental effects on mechanical behavior are also included. The emphasis is on metals; however, polymers and ceramics are also covered. Graduate standing or special permission. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 585 Cast Metals in Engineering Design 3 Credit Hours
An understanding of the properties of the most important cast metals is obtained by melting, casting, and testing. In addition to measurement of mechanical properties, resistance to heat, wear, and corrosion is discussed. The application of these properties in the design of critical parts in the aircraft, automotive, chemical, mining, and railroad industries is presented by case histories and examination of castings. Graduate standing or special permission. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 586 Materials Consideration in Manufacturing 3 Credit Hours
Manufacturability of materials and influence of processing variables on the properties of manufactured products are important considerations in materials selection and product design. These issues are addressed on the basis of mechanical deformation and thermal characteristics of materials during processing. Test methods to measure formability, castability, machinability, etc., are critically discussed. Defects in manufactured products including their origin and detection are also discussed. Graduate standing or special permission. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 589 Composite Materials 3 Credit Hours
This course will consider four different aspects of composite materials; namely, materials, mechanics, manufacturing and design. Recent developments on fiber reinforced plastics and metals will be covered. Fundamental analytical concepts on micro and macro mechanics will be emphasized to create a better understanding of the design principles of composite materials. Graduate standing or special permission. (OC).
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 591 Degradation of Materials 3 Credit Hours
The course will introduce students to the fundamentals of corrosion and degradation behavior of materials. The degradation of metals, polymers and composites will be discussed. Monitoring and life prediction techniques will be covered. Preventive measures such a materials selection and design, protective coating, surface treatments, inhibitors, and electrochemical techniques are applied, when they should be used, and how various techniques can be integrated to solve complex problems. (AY).
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Doctorate or Rackham or Graduate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 592 Fundamentals of Fuel Cells 3 Credit Hours
This course covers fundamentals of fuel cell systems for both automotive and distributed power applications. Detailed descriptions of the principles and component designs of various types of fuel cells including proton exchange membrane fuel cell (PEMFC), phosphoric acid fuel cell (PAFC), solid oxide fuel cell (SOFC), and molten carbonate fuel cell (MCFC). Discussions on water and thermal management, and balance of power plant. Review of hydrogen storage and safety consideration. Challenges and future opportunities. (OC).
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 593 Powder Materials & Processing 3 Credit Hours
A lecture course that provides a comprehensive understanding of the theory and principles, the associated synthesis, processing, and characterization techniques; and the applications of powder and particulate materials. The students will gain knowledge of the following: fundamentals of powder and particulate materials (metals and ceramics), various metallic and non-metallic powder synthesis/production techniques, diverse techniques of powder characterization, and the principles and methods of homogenization, compaction, and sintering. Students will be exposed to the relevant criteria for designing parts/components based on powder and particulate materials and, will familiarize themselves with a wide range of applications-as structual, functional, and biomedical components made of metallic, ceramic, and composite powders-in various industries. (OC)
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 595 Digital Manufacturing and Product Innovation 3 Credit Hours
This combined lecture and hands on project course aims to train students to optimize the interplay of materials, people, machines and profitability. The course introduces methods to identify product concepts with commercial potential. Student teams will perform market analysis and explore the intellectual property space around their ideas and rapidly iterate them into a final prototype via direct digital manufacturing (e.g., 3D CAD/CAM files manifested via digital printing or machining). Advanced instruction on direct digital manufacturing tools will be given, and customer response will be used as feedback. Early stage prototypes will progress into more sophisticated designs, scaling up (cost, pricing, tooling, process flow and automation) scenario planning for mass manufacturing as well as Failure Mode Effect Analysis (FMEA) will be discussed. (W,YR)
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 596 Internal Combustion Engines I 3 Credit Hours
Comparison of several forms of internal combustion engines including Otto and Diesel-type piston engines; performance parameters and testing; thermodynamic cycles and fuel-air cycles; combustion in SI and Diesel engines; charge formation and handling; ignition; elements of exhaust emissions. (Not available to students with ME 496 or equivalent background.)
Prerequisite(s): ME 330 or ME 325
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if College is Engineering and Computer Science
Can enroll if Major is Automotive Systems Engineering

ME 597 Internal Combustion Engines II 3 Credit Hours
Fuel flow and air flow measurements and techniques; engine maps; fuel and ignition control and control strategies; combustion and burn rate considerations in engine design; intake and exhaust systems; emissions and control strategies; emission test procedures. (OC).
Prerequisite(s): AENG 596 or ME 596
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 598 Engine Emissions 3 Credit Hours
This course introduces students to the fundamentals of engine exhaust emissions, including their formation mechanisms and abatement techniques. The students will be familiarized with the present emission control technologies and future challenges. The topics covered include: engine emissions and air pollution; review of emission regulations; catalyst fundamentals; catalyst aftertreatment techniques for gasoline, diesel, and lead-burn engines; discussion of cold start emission control and breakthrough catalytic technologies. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 600 Study or Research in Selected Mechanical Engineering Topics 1 to 3 Credit Hours
Individual or group study or design in an area of Mechanical Engineering under the supervision of a member of the graduate faculty. The student will submit a report on the project and give an oral presentation to a panel of faculty members at the close of the term. Graduate standing or special permission. (YR).
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate or Doctorate or

ME 601 Experimental Research in Mechanical Engineering 1 to 3 Credit Hours
Laboratory investigation in an area of Mechanical Engineering under the supervision of a member of the graduate faculty. The student will submit a report on the project and give an oral presentation to a panel of faculty members at the close of the term. Graduate standing or special permission. (YR).
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate or Doctorate or

ME 602 Guided Graduate Study in Mechanical Engineering 1 to 6 Credit Hours
Independent Study of specified material in an area of Mechanical Engineering under the guidance of a member of the graduate faculty. The student will submit a report on the project and give an oral presentation to a panel of faculty members at the close of the term.
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate or Doctorate or

ME 607 Advanced Mechanical Engineering Problems 3 Credit Hours
A graduate-level analytical study of selected topics in mechanical engineering. The subjects of study in each term usually depend on student and instructor interest. Typical areas of study include vibrations of continuous or lumped systems, fluid mechanics, devices, thermodynamics, heat transfer, mechanics of solids, materials, or processing, etc. The course can be organized to meet the subject needs of a group of students with mutual interests.
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering

ME 610 Finite Element Methods--Nonlinear 3 Credit Hours
Review of FE theory in linear static. FEA in dynamics. FEA in heat transfer. FEA in fluid mechanics. FEA in nonlinear problems; material and geometrical nonlinearities, total and updated Lagrangian formulations, solution techniques. Use of FE codes. Graduate standing or special permission. (OC).
Prerequisite(s): ME 510
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Mechanical Engineering

ME 611 Modeling of Engineering Materials 3 Credit Hours
Full Course Title: Modeling of Engineering Materials This course will present the mathematical models and constitutive behavior of engineering materials subjected to mechanical and non-mechanical loads. It will consider both linear and non-linear models to describe elastic, plastic, viscoelastic, viscoplastic, hypo-and hyper-elastic response of materials to mechanical loads. Non-mechanical loads will include thermal and electro-mechanical fields. Micro-scale and multi-scale mechanical modeling will also be introduced. (OC)
Prerequisite(s): ME 518
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Program is

ME 622 Advanced Topics in Fluid Mechanics 3 Credit Hours
The course presents selected topics of contemporary advanced fluid mechanics, such as the hydrodynamic stability theory, turbulence, multi-phase flows, magnetohydrodynamics, interfacial flows, flows of non-newtonian fluids, micro- and nano-fluid mechanics, biofluid mechanics, etc.
Prerequisite(s): ME 522
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Program is

ME 640 Advanced Vibration Theory 3 Credit Hours
The course will emphasize the similarities between various types of continuous systems as well as common features of continuous and discrete systems. Variational principle will be introduced as a notion of natural modes of vibration for discrete systems is reviewed. Natural modes of vibration for continuous systems will be discussed using the boundary value formulation, the general formulation of the eigenvalue problem and orthogonality. These concepts will be applied to bars, rods, membranes, and plates. Approximate methods will be introduced to determine the natural modes of vibration for complex continuous systems. A few methods to be considered include the Rayleigh-Ritz, Galerkin, Collocation, Myklestad, and Lumped-parameter methods. All the approximate methods presented will allow expedient numerical solution by means of high-speed computers. The damped and undamped response to deterministic excitations will be considered for various systems. Graduate standing or special permission. (OC).
Prerequisite(s): ME 540
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or

ME 674 Advanced Topics in Heat Transfer 3 Credit Hours
The course presents selected topics of contemporary advanced heat transfer, including, but not limited to radiation in participating media, heat transfer at nanoscales, heat transfer in the presence of phase change, cooling of electronic components, liquid-metal heat exchangers, heat transfer in biological systems, etc. (OC).
Prerequisite(s): ME 572 or ME 574
Restriction(s):
Can enroll if Level is Doctorate or Rackham or Graduate or
Can enroll if Major is , Mechanical Engineering

ME 675 Predictive Control of Dynamic Systems 3 Credit Hours
This course covers predictive control of dynamic systems to students working on controls. The topics will include unconstrained and constrained optimization, discrete-time optimal control problems, dynamic programming, stability, invariance, reachability, and linear predictive control problems with application examples in mechanical engineering. (OC).
Prerequisite(s): ME 564 or ECE 560
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if College is Engineering and Computer Science

ME 699 Master's Thesis 1 to 6 Credit Hours
Graduate students electing the course, while working under the general supervision of a member of the department faculty, are expected to plan and carry out the work themselves and submit a thesis for review and approval, and also present an oral defense of the thesis. Students must satisfactorily complete 6 credit hours in ME 699, but these hours may be spread over more than one term. Graduate standing or special permission. (YR).
Restriction(s):
Can enroll if Class is Graduate

ME 791 Advanced Guided Research 1 to 6 Credit Hours
Independent study and research work on the material related to the doctoral research project under the guidance of the faculty advisor. The course is for doctoral students who have not completed the PhD program's coursework requirements. A report and an oral presentation are required. (F,W,S)
Restriction(s):
Can enroll if Level is or Doctorate
Can enroll if College is Engineering and Computer Science
Can enroll if Major is

ME 798 Doctoral Seminar 0 Credit Hours
Every Ph.D. student is required to attend and actively participate in research seminars given by the CECS Dean's office or individual departments in CECS. A student gets a satisfactory grade if they attend at least two research seminars during the course period. (F, W, S).
Restriction(s):
Can enroll if Level is or Doctorate
Can enroll if Major is

ME 980 Pre-Candidate Dissertation Research 1 to 9 Credit Hours
Full Title: Pre-Candidate Dissertation Research Dissertation work by a pre-candidate student in Mechanical Sciences and Engineering program conducted under guidance of the faculty advisor. (F,W,S)
Restriction(s):
Can enroll if Level is Doctorate or
Can enroll if Major is

ME 990 Doctoral Dissertation 1 to 12 Credit Hours
Dissertation work by a student of the Ph.D. in Mechanical Sciences and Engineering Program conducted under guidance of the faculty advisor. The student must be admitted to the Ph.D. candidacy status.
Restriction(s):
Can enroll if Level is Doctorate or
Can enroll if Major is

*An asterisk denotes that a course may be taken concurrently.

Frequency of Offering

The following abbreviations are used to denote the frequency of offering: (F) fall term; (W) winter term; (S) summer term; (F, W) fall and winter terms; (YR) once a year; (AY) alternating years; (OC) offered occasionally