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 covering all courses elected. These 30 credit hours must include two graduate-level cognate courses for a minimum of three credit hours each in a department other than mechanical engineering. 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.

Requirements

Within the broad framework given above, the student must elect courses to fulfill the following distribution requirements:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 518</td>
<td>Advanced Engineering Analysis (^1)</td>
<td>3</td>
</tr>
<tr>
<td>Two courses from Group A</td>
<td>6</td>
<td></td>
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<tr>
<td>Two courses from Group B</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>One mathematics or math-related cognate course (^2)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>One non-ME 500-level cognate course</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Three ME graduate courses as Electives</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Thesis optional:</td>
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</tr>
<tr>
<td>6 credit hours, to be deducted from Electives area.</td>
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<tr>
<td>Total Credit Hours</td>
<td>30</td>
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</tbody>
</table>

\(^1\) Must be taken within the first two terms of enrollment.

\(^2\) e.g., IMSE 510, IMSE 511, or any 500 level MATH or STAT course

**Group A: Mechanical Science Courses**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>ME 510</td>
<td>Finite Element Methods</td>
<td>3</td>
</tr>
<tr>
<td>ME 512</td>
<td>Structural Analysis</td>
<td>3</td>
</tr>
<tr>
<td>ME 514</td>
<td>Advanced Stress Analysis</td>
<td>3</td>
</tr>
<tr>
<td>ME 515</td>
<td>Advanced Mechanics of Solids</td>
<td>3</td>
</tr>
<tr>
<td>ME 516</td>
<td>Special Topics in Mech Eng</td>
<td>3</td>
</tr>
<tr>
<td>ME 519</td>
<td>Basic Comp Methods in Eng</td>
<td>3</td>
</tr>
<tr>
<td>ME 540</td>
<td>Mechanical Vibrations</td>
<td>3</td>
</tr>
<tr>
<td>ME 542</td>
<td>Advanced Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>ME 543</td>
<td>Vehicle Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>ME 545</td>
<td>Acoustics and Noise Control</td>
<td>3</td>
</tr>
<tr>
<td>ME 547</td>
<td>Powertrains I</td>
<td>3</td>
</tr>
<tr>
<td>ME 548</td>
<td>Automotive Powertrains II</td>
<td>3</td>
</tr>
<tr>
<td>ME 554</td>
<td>Theory of Gearing and Applicat</td>
<td>3</td>
</tr>
<tr>
<td>ME 556</td>
<td>Stress and Stren Cons in Design</td>
<td>3</td>
</tr>
<tr>
<td>ME 558</td>
<td>Fracture and Fatig Cons in Des</td>
<td>3</td>
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</tbody>
</table>

**Group B: Thermal/Fluid Science Courses**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 610</td>
<td>Finite Elem Methods--Nonlinear</td>
<td>3</td>
</tr>
</tbody>
</table>

**Thesis and Independent Study**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 600</td>
<td>Study or Res in Sel Mech Eng</td>
<td>1-3</td>
</tr>
<tr>
<td>ME 601</td>
<td>Exper Research in Mech Eng</td>
<td>1-3</td>
</tr>
<tr>
<td>ME 602</td>
<td>Guided Study in Mech Eng</td>
<td>1-6</td>
</tr>
<tr>
<td>ME 699</td>
<td>Master's Thesis</td>
<td>1-6</td>
</tr>
</tbody>
</table>

Students must earn a B or better in every graduate course to be credited toward the degree requirements. However, a maximum of one grade of B-
will be accepted. 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.

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):
Can enroll if Major is , Bioengineering, Mechanical Engineering, Mechanical Engineering-NCFD

ME 512  Structural Analysis  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 Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 514  Advanced Stress Analysis  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. (YR).

Restriction(s):
Can enroll if Major is Mechanical Engineering-NCFD, Mechanical Engineering

ME 515  Advanced Mechanics of Solids  3 Credit Hours

Restriction(s):
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):
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 516A  Special Topics in Mech Engin  3 Credit Hours
TOPIC: Tribology This course provides fundamental concepts of tribology (friction, lubrication and wear). In addition to the theory of tribology, practical aspects of designing for wear life and frictional performance are covered. Topics to be included are lubricants, wear mechanisms for metals, polymers and ceramics, surface engineering, tribological modeling, engine triboloby and tool tribology. (OC).

Restriction(s):
Can enroll if Class is Graduate

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):
Can enroll if Major is , Bioengineering, Mechanical Engineering, Mechanical Engineering-NCFD

ME 519  Basic Comp Methods in Eng  3 Credit Hours
An introduction to basic numerical methods in engineering. Topics covered include solutions of linear and nonlinear algebraic equations, solution of initial and boundary value problems in engineering by shooting, finite-difference and transformation techniques, computer-aided perturbation, numerical inversion of Laplace transformation. Finite-element methods. Solutions of partial differential equations. Graduate standing or special permission. (YR).

Restriction(s):
Can enroll if Major is Bioengineering, Mechanical Engineering, Mechanical Engineering-NCFD,

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):
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. (W,YR)

Restriction(s):
Can enroll if Major is Mechanical Engineering-NCFD, Bioengineering, Mechanical Engineering
ME 525  Computational Thermo-Fluids  3 Credit Hours

Prerequisite(s): ME 518
Restriction(s):
Can enroll if Major is Mechanical Engineering, Bioengineering, Mechanical Engineering-NCFD

ME 528  Fund of Boiling and Condensation  3 Credit Hours
An introduction to the basic elements of condensation and vaporization processes. Topics cover fundamentals such as gas-liquid interfacial phenomena; phase stability and nucleation; two phase flow regimes, and critical heat flux. The course also includes special topics and applications such as convective vaporization and condensation in heat transfer equipment. Three Lecture hours per week.

Restriction(s):
Can enroll if Major is Mechanical Engineering-NCFD, Mechanical Engineering

ME 531  Statistical Thermodynamics  3 Credit Hours
Introduction to statistical methods of evaluating thermodynamic and transport properties. Elements of quantum mechanics, statistical mechanics, and kinetic theory, as applied to engineering thermodynamics. Graduate standing or special permission. (YR).

Restriction(s):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD

ME 532  Combustion Processes  3 Credit Hours

Prerequisite(s): ME 371*
Restriction(s):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD

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. (YR).

Restriction(s):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD

ME 537  Automotive Air Conditioning  3 Credit Hours
Applications of HVAC fundamentals to analysis and design of automotive air conditioning systems. Topics include psychrometrics, thermal comfort, refrigeration cycles and system design, heating system design, air flow circuits, air space diffusion, compact heat exchanger design, and instrumentation/controls.

Restriction(s):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD,

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):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD,

ME 540  Mechanical Vibrations  3 Credit Hours

Restriction(s):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD, Bioengineering

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. (YR).

Restriction(s):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD, Bioengineering

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.

Restriction(s):
Can enroll if Major is Mechanical Engineering-NCFD, Mechanical Engineering-NCFD,

ME 544  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. (YR).

Restriction(s):
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):
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 axes, four-wheel-drive systems; design and manufacturing of gearing systems.
Prerequisite(s): AENG 547 or ME 547
Restriction(s):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD

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 Major is Mechanical Engineering, Mechanical Engineering-NCFD,

ME 554  Theory of Gearing and Applicat  3 Credit Hours
The course emphasizes the theory and methodology for the design, manufacturing and analysis of gears and other engineering surfaces. Topics include differential geometry, kinematics of conjugate motions, surface enveloping, curvatures, cutter design, machine tool settings, simulation of machining process, tooth contact analysis, geometry modeling and design of power transmissions. Graduate standing or special permission. (YR).
Restriction(s):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD,

ME 556  Stress and Stren Cons in Desgn  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. (YR).
Restriction(s):
Can enroll if Level is Graduate or Rackham
Can enroll if Major is Mechanical Engineering-NCFD, Mechanical Engineering,

ME 558  Fracture and Fatig Cons in Des  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. (YR).
Restriction(s):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD

ME 560  Experimental Methods in Design  3 Credit Hours
Planned experiments and their statistical analysis. Emphasis on application in life and strength testing. Graduate standing or special permission. (YR).
Restriction(s):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD

ME 563  Advanced Instrum and Control  3 Credit Hours
Analysis of design techniques in modern control theory are presented. State space concepts, digital control, and adaptive control methods are covered, along with information on practical implementation problems experienced with these control techniques. Graduate standing or special permission. (YR).
Restriction(s):
Can enroll if Level is Rackham or Graduate
Can enroll if Major is Bioengineering, Mechanical Engineering, Mechanical Engineering-NCFD

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. (AY).
Restriction(s):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD,

ME 566  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. (AY).
Restriction(s):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD,

ME 567  Reliability Consid in Design  3 Credit Hours
Theory and application of common statistical distributions to the analysis of both life and strength data for components. Introduction to system reliability. Emphasis on use of digital computer in reliability simulation and analysis. Graduate standing or special permission. (YR).
Restriction(s):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD,
ME 570  Powertrain NVH of Elect Veh  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.
Restriction(s):
Can enroll if Major is , Mechanical Engineering-NCFD, Mechanical Engineering

ME 571  Conduction Heat Transfer  3 Credit Hours
Conduction heat transfer in steady and transient state, including heat sources. Analytical, numerical, graphical, and analog methods of solution for steady and fluctuating boundary conditions. Thermal stresses. Dynamics of thermal instrumentation and heat exchangers. Graduate standing or special permission. (YR).
Restriction(s):
Can enroll if Major is Bioengineering, Mechanical Engineering, Mechanical Engineering-NCFD,

ME 572  Convection Heat Transfer  3 Credit Hours
The course is primarily concerned with the determination of the rate of heat transfer due to the transport of energy to or from surfaces by both molecular conduction processes and gross fluid movement inside channels and over external surfaces. Emphasis will be placed on basic understanding of the convection heat transfer phenomena and the necessary mathematical techniques for the solution of such problems along with engineering applications. Graduate standing or special permission. (YR).
Restriction(s):
Can enroll if Major is Mechanical Engineering-NCFD, Mechanical Engineering, Bioengineering,

ME 573  Radiative Transport of Heat  3 Credit Hours
Restriction(s):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD

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):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD

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. (YR).
Restriction(s):
Can enroll if Major is , Mechanical Engineering, Mechanical Engineering-NCFD

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. (YR).
Restriction(s):
Can enroll if Major is Mechanical Engineering-NCFD, Mechanical Engineering,

ME 583  Mechanical Behav 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. (YR).
Restriction(s):
Can enroll if Major is , Mechanical Engineering, Mechanical Engineering-NCFD

ME 584  Mechanical Behavior of Polymer  3 Credit Hours
Mechanical behavior of polymers and ceramics are considered in relation to their structures, processing and applications. Emphasis is given on their deformation, fatigue and fracture characteristics. Strengthening mechanisms for both materials are discussed. Graduate standing or special permission. (YR).
Restriction(s):
Can enroll if Major is , Mechanical Engineering, Mechanical Engineering-NCFD

ME 585  Cast Metals in Eng 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. (YR).
Restriction(s):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD,
ME 586  Materials Consid in Manufactur  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. (YR).
Restriction(s):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD

ME 587  Automotive Composites  3 Credit Hours
The emphasis in this course is on automotive composites, such as SMC, SRIM and RTM. In addition to properties and applications of these materials, this course covers manufacturing processes, design considerations, test methods and quality control techniques used for automotive composites. The use of continuous fiber composites in automotive applications, such as leaf springs, drive shafts and energy absorbing structures, are also discussed. (YR).
Restriction(s):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD

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. (YR).
Restriction(s):
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):
Can enroll if Major is Mechanical Engineering-NCFD, Mechanical Engineering

ME 592  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.
Restriction(s):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD

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 structural, functional, and biomedical components made of metallic, ceramic, and composite powders-in various industries. (OC)
Restriction(s):
Can enroll if Major is Mechanical Engineering-NCFD, Mechanical Engineering

ME 595  Digital Manufacturing  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 Major is Mechanical Engineering-NCFD

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.)
Restriction(s):
Can enroll if Major is Mechanical Engineering-NCFD

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.
Prerequisite(s): AENG 596 or ME 596
Restriction(s):
Can enroll if Major is Mechanical Engineering-NCFD
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. (AY).
Restriction(s):
Can enroll if Major is Mechanical Engineering, Mechanical Engineering-NCFD

ME 600  Study or Res in Sel Mech Eng  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):
Can enroll if Class is Graduate
Can enroll if Level is Rackham or Graduate

ME 601  Exper Research in Mech Eng  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):
Can enroll if Class is Graduate
Can enroll if Level is Rackham or Graduate

ME 602  Guided Study in Mech Eng  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):
Can enroll if Class is Graduate

ME 607  Adv Mechanical Engin 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):
Can enroll if Class is Graduate

ME 610  Finite Elem 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. (YR).
Prerequisite(s): ME 510
Restriction(s):
Can enroll if Class is Graduate

ME 622  Adv Topics in Fluid Mechanics  3 Credit Hours
The course presents selected topics of contemporary advanced fluid mechanics, such as the hydrodynamic stability theory, turbulence, multiphase flows, magnetohydrodynamics, interfacial flows, flows of non-Newtonian fluids, micro- and nano-fluid mechanics, biofluid mechanics, etc.
Prerequisite(s): ME 522
Restriction(s):
Can enroll if Class is Graduate
Can enroll if Level is Doctorate or Rackham or Graduate
Can enroll if Program is MSE-Automotive Engineering, PHD-Automotive Engineering, MSE-Mechanical Engineering

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. (YR).
Prerequisite(s): ME 540
Restriction(s):
Can enroll if Level is Graduate or Rackham

ME 642  Simulation of Mechanic Systems  3 Credit Hours
Analysis, synthesis, and optimization of linear, multilinear and nonlinear mechanical systems with the electronic analog computer. Graduate standing or special permission. (YR).
Prerequisite(s): ECE 365
Restriction(s):
Can enroll if Level is Rackham or Graduate

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  Adv 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 Doctorate
Can enroll if College is Engineering and Computer Science
Can enroll if Major is Mechanical Engineering
ME 798  Doctoral Seminar  0 Credit Hours
After attaining candidacy, every Ph.D. students is required to attend and actively participate in research seminars given by CECS Dean's office or individual departments in CECS. A student gets a satisfactory grade if he/she attends at least two research seminars during the course period. (F,W,S)
Restriction(s):
Can enroll if Level is Doctorate
Can enroll if Major is

ME 980  Pre-Cand 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
Can enroll if Major is

ME 990  Doctoral Dissertation  1 to 9 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
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