Mechanical Engineering (ME)

ME 111. Introduction to Mechanical Engineering. 2 Credits.
This course introduces students to the field of mechanical engineering, the Mechanical Engineering degree program at NDSU, and potential career opportunities in the discipline through the use of hands-on, project-based learning experiences in multi-member teams addressing traditional and newly emerging topics in the field of mechanical engineering, including computer aided design, solid mechanics, fluid dynamics, thermodynamics, materials selection, instrumentation and data analysis in the context of problem-solving and design. Prereq: Acceptance into the Pre-Mechanical Engineering major.

ME 189. Skills for Academic Success. 1 Credit.
This course is designed to ease the transition for new students at NDSU. Students will learn skills and techniques used by successful college students. In addition to introducing the students to campus resources and governance, topics will include study techniques, time management, test taking, note taking, goal setting, wellness, stress management, and career orientation.

ME 194. Individual Study. 1-5 Credits.

ME 196. Field Experience. 1-15 Credits.

ME 199. Special Topics. 1-5 Credits.

ME 212. Fundamentals of Visual Communication for Engineers. 3 Credits.
Visual communications for design and manufacturing, computer-aided drawing and design, three-dimensional modeling and orthographic projections, geometric dimensioning and tolerancing, ASME Y14.5 1994 standard, sketching, parametric modeling, drawings and assemblies. F, S.

ME 213. Modeling of Engineering Systems. 3 Credits.
Introduction to numerical methods used in the solution of engineering problems; computer methods, programming, and graphics; engineering system modeling and simulation; case studies. Prereq: MATH 166. Coreq: MATH 129.

ME 221. Engineering Mechanics I. 3 Credits.
Scaler and vector approaches to trusses, frames and machines, internal forces, friction forces, center of gravity, centroid, and moment inertia. Prereq: MATH 165.

ME 222. Engineering Mechanics II. 3 Credits.
Dynamics of particles and rigid bodies, work energy, impulse-momentum, principles of conservation of energy and momentum. Prereq: ME 221, MATH 166.

ME 223. Mechanics of Materials. 3 Credits.
Introduction to stress, strain, and their relationships; torsion of circular shafts, bending stresses, deflection of beams, stress transformations. Prereq: ME 221.

ME 291. Seminar. 1-3 Credits.

ME 292. Global Practicum: Study Abroad. 1-15 Credits.
Pre-Arranged study at accredited foreign institutions (study abroad), domestic institutions (National Student Exchange) or on approved study abroad programs. Pre-requisite: Sophomore standing and prior approval by International Student and Study Abroad Services and major department. Graded 'P'or 'F' (Undergraduate), or 'S' or 'U' (Graduate).

ME 294. Individual Study. 1-5 Credits.

ME 299. Special Topics. 1-5 Credits.

ME 311. Introduction To Aviation. 3 Credits.
General introduction to aviation and preparation for FAA examination for Private Pilot License, study of FAA regulations, weather conditions, visual and radio navigation. F, S.

ME 312. Introduction to Flight. 2 Credits.
Instruction in flight procedures, operation of aircraft, and introduction to solo flight. Completion of 15 hours of dual flight instruction required. Coreq: ME 311. F, S.

ME 313. Commercial Instrument Ground School. 3 Credits.
Preparation of student for FAA written examination for Commercial Certificate and Instrument Rating License; study of commercial flight maneuvers and instrument flying and procedures. Prereq: ME 311 or holder of private pilot license. On demand.

ME 331. Materials Science and Engineering. 4 Credits.
Characterization of microscopic structures and associated macroscopic properties and performance of mechanical engineering design materials (metals, ceramics, plastics) and processing effects. Includes laboratory. Includes laboratory. Prereq: CHEM 122, ME 223 and admission to the Mechanical Engineering major.

ME 332. Engineering Materials II. 3 Credits.
Characterization of properties and processes in metals; diffusion, phase diagrams, phase transformation, creep, wear, corrosion, fracture, and fatigue. Prereq: ME 331 and admission to the Mechanical Engineering major.

ME 350. Thermodynamics and Heat Transfer. 3 Credits.
Basic concepts, first and second laws of thermodynamics; introduction to heat transfer principles. Prereq: ME 222 or equivalent. For non-mechanical engineering majors.

ME 351. Thermodynamics I. 3 Credits.
Basic concepts, properties of pure substances and ideal gases. First and second law, entropy, and availability. Prereq: ME 221.

ME 352. Fluid Dynamics. 3 Credits.
Foundations of the science of fluid dynamics. Basic concepts including thermodynamic principles applied to fluids. Development of conservation principles and applications. Prereq: ME 351 and admission to the Mechanical Engineering major.

ME 353. Thermodynamics II. 3 Credits.
Continuation of Thermodynamics I. Cycle analysis, thermodynamic relations, mixtures, chemical reactions, and related topics. Prereq: ME 351 and admission to the Mechanical Engineering major.

ME 361. Product Design and Development. 3 Credits.
This course provides an insight into the mechanical design process with the focus on developing a new product with thoughtful implementation of human-centered design (robust design, design for environment, human factors, etc.). Topics on project planning and scheduling and conceptual design process will be covered. In addition, this course provides students with an introduction into the business aspects of project management and product development. Requires admission to the Mechanical Engineering major.

ME 379. Global Seminar. 1-6 Credits.
NDSU instructed experience or field study in a foreign country. Conducted in English for residence credit. Pre-requisite: Prior approval by International Student and Study Abroad Services and major department. May be repeated. Standard Grading.

ME 391. Seminar. 1-3 Credits.

ME 392. Global Practicum: Study Abroad. 1-15 Credits.
Pre-Arranged study at accredited foreign institutions (study abroad), domestic institutions (National Student Exchange) or on approved study abroad programs. Pre-requisite: Sophomore standing and prior approval by International Student and Study Abroad Services and major department. Graded 'P'or 'F' (Undergraduate), or 'S' or 'U' (Graduate).

ME 394. Individual Study. 1-5 Credits.

ME 397. Fe/Coop Ed/Internship. 1-4 Credits.

ME 399. Special Topics. 1-5 Credits.

ME 412. Engineering Measurements. 3 Credits.
Principles and characteristics of instruments used for engineering measurements, statistical analysis of data, signal conditioning, data acquisition systems. Includes laboratory. Prereq: ECE 306, ME 213 and admission to the Mechanical Engineering major. {Also offered for graduate credit - see ME 612.}.

ME 421. Theory of Vibrations. 3 Credits.
Fundamentals of vibrations; free, forced, and damped vibration of single and multiple degrees of freedom systems. Prereq: ME 213, MATH 266 and admission to the Mechanical Engineering major. {Also offered for graduate credit - see ME 621.}.

ME 435. Plastics and Polymer Processing in Manufacturing. 3 Credits.
Product and process engineering for manufacturers of plastic products; material evaluation and selection, mold design, process design, quality evaluation of manufactured plastic parts. Prereq: MATH 266. {Also offered for graduate credit - see ME 635.}.

ME 436. Biopolymers and Biocomposites. 3 Credits.
Structure/properties/synthesis of biopolymers, biomaterials and engineered biocomposites derived from plant based materials. An interdisciplinary course designed for undergraduate students. Introduction to science and engineering of converting biorenewable resources into novel biobased materials and products. Introduction to principles and concepts critical to successful design of polymeric biomaterials, coatings, and biocomposites. Understanding environmental impacts through life cycle analysis (LCA). Prereq: CHEM 122 and at least junior standing. Cross-listed with CHEM 436 and CPM 436. {Also offered for graduate credit - See ME 636.}.

ME 437. Engineering Ceramics. 3 Credits.
Study the crystal and defect structures to determine the electrical and mass transport behaviors in ceramic materials. Investigation on microstructure of ceramic materials and its effect on optical, magnetic, dielectic, and thermo-mechanical properties. Prereq: ME 223, ME 331 and admission to the Mechanical Engineering major.

ME 442. Machine Design I. 3 Credits.
Application of engineering mechanics, material properties, and failure theories to the design of reliable machine components. Prereq: Admission to Mechanical Engineering major. Co-req: ME 331. {Also offered for graduate credit - see ME 642.}.

ME 443. Machine Design II. 3 Credits.
Application of methods, procedures, and standards used in the design and selection of mechanical components and elements, including springs, roller and journal bearings, gears, brakes, belts and flexible elements. Prereq: ME 442 and admission to the Mechanical Engineering major. {Also offered for graduate credit - see ME 643.}.

ME 454. Heat and Mass Transfer. 3 Credits.
Principles of heat transfer by conduction, convection, and radiation. Introduction to mass transfer principles. Prereq: ME 213, ME 352, MATH 266 and admission to the Mechanical Engineering major. {Also offered for graduate credit - see ME 654.}.

ME 457. Thermal Systems Laboratory. 3 Credits.
Investigation of thermal, fluid and mechanical systems and instrumentations. Statistical methods are used in data collection and analysis. Prereq: Admission to the Mechanical Engineering major. Co-req: ME 454.

ME 461. Design Project I. 3 Credits.
Capstone student project in design, analysis, and experimental investigation in mechanical engineering. Prereq: ME 361. Coreq: ME 443, ME 454, Senior standing in ME. Requires admission to Mechanical Engineering major.

ME 462. Design Project II. 3 Credits.
Capstone student project in design, analysis, and experimental investigation in mechanical engineering. Prereq: ME 461 and admission to the Mechanical Engineering major.

ME 466. Basic Principles of Unmanned Vehicles. 3 Credits.
This course equips students with basic knowledge of the principles of unmanned ground, air, and underwater vehicles. Students learn engineering principles involved in developing unmanned vehicles, which include locomotion systems, path planning, control, and navigation systems. Prereq: ME 213 or ECE 173 and ECE 301 or ECE 331. Prereq or Coreq: Admission to a ME Program and at least junior standing. Dual-listing: ME 666.

ME 468. Introduction to Biomechanics. 3 Credits.
Introduction to the fundamentals of biomechanics including force analysis, mechanics of deformable bodies; stress and strain, transport phenomena, and viscoelasticity, as well as their applications on the biomechanics of soft and hard tissues. Prereq: ME 223 and ME 352 and admission to the Mechanical Engineering major. {Also offered for graduate credit - see ME 668.}.

ME 469. Energy Storage Technology. 3 Credits.
This course will cover the fundamentals of energy storage. It will provide an introduction to the principles of thermal, mechanical, and electrochemical storage technologies. Prereq: ME 350 or ME 351 and MATH 266. Prereq or Coreq: Mechanical Engineering major only. Dual-listing: ME 669.

ME 470. Renewable Energy Technology. 3 Credits.
Introduction to renewable energy technology, solar thermal energy systems, solar photovoltaic systems, wind turbines; biomass; bio-fuels; urban waste to energy from pyrolysis plants; hydrogen energy and fuel cells. Prereq: ME 350 or ME 351 and admission to the Mechanical Engineering major. {Also offered for graduate credit - see ME 670.}.

ME 471. Experimental Stress Analysis. 3 Credits.
Introduction to experimental techniques for the measurement of stresses and strains, including strain gages, optical methods, photoelasticity, and brittle coatings. Prereq: ME 442 and admission to Mechanical Engineering major. {Also offered for graduate credit - see ME 671.}.

ME 472. Fatigue and Fracture of Metals. 3 Credits.
Causes and effects of fatigue failure and fracture of metals, analytical methods for fatigue design and fatigue life prediction, fatigue crack initiation and propagation, fatigue testing and validation. Prereq: ME 442 and admission to Mechanical Engineering major. {Also offered for graduate credit - see ME 672.}.

ME 473. Engineering with Polymeric Materials. 3 Credits.
This course will introduce basic polymer materials including plastics, rubbers, adhesives; structures, properties, and relationships of polymers; additives; processing technologies, applications and development. Prereq: ME 331 and admission to the Mechanical Engineering major. {Also offered for graduate credit - see ME 673}.

ME 474. Mechanics of Composite Materials. 3 Credits.
Materials, properties, stress, and strength analyses; engineering design and manufacturing aspects of short and continuous fiber-reinforced materials. Prereq: ME 331 and admission to the Mechanical Engineering major. {Also offered for graduate credit - see ME 674.}.

ME 475. Automatic Controls. 3 Credits.
Introduction to industrial automatic controls. Theory and applications of pneumatic control, continuous process control, and programmable logic control. Demonstrations and discussion of the current industrial practice. Prereq: MATH 266 and admission to the Mechanical Engineering major. {Also offered for graduate credit - see ME 675.}.

ME 476. Mechatronics. 3 Credits.
Design and development of mechatronic systems that require an integrated knowledge of mechanical engineering, electronics, computer science and control theory. Prereq: ECE 301 or ECE 311 and admission to the Mechanical Engineering major. {Also offered for graduate credit - see ME 676.}.

ME 477. ME Finite Element Analysis. 3 Credits.
Introduction to the finite element method and its application to problems in mechanical engineering, including stress analysis. Prereq: ME 442 and ME 213 or ABEN 255 and admission to the Mechanical Engineering major. {Also offered for graduate credit - see ME 677.}.

ME 478. Advanced Flow Diagnostics. 3 Credits.
Introduction and review of fundamentals of advanced thermal and fluid measurement techniques for engineering applications including advanced laser and optical diagnostics, high speed imaging, infrared thermography, fiber optics, fluorescence, etc. Prereq: ME 352 and admission to the Mechanical Engineering major. {Also offered for graduate credit - See ME 678}.

ME 479. Fluid Power Systems Design. 3 Credits.
Fluid dynamics principles and fluid properties are applied to the study of function, performance, and design of system components and systems for power transmission and control purposes. Prereq: ABEN 263 or CE 309 or ME 352. Cross-listed with ABEN 479. {Also offered for graduate credit - see ME 679.}.

ME 480. Biofluid Mechanics. 3 Credits.
Overview of fluid dynamical phenomena in biological systems; flow behavior of fluids in living organisms; application of fluid mechanics to the cardiovascular system and blood circulation. Prereq: ME 352 and admission to the Mechanical Engineering major. {Also offered for graduate credit - see ME 680.}.

ME 481. Fundamentals of Energy Conversion. 3 Credits.
Foundations of the engineering of energy conversion. Introduction to electrical power generating systems and their major components. Concepts and designs in thermodynamic cycles for engineering applications. Prereq: ME 350 or ME 351. Prereq or Coreq: Mechanical Engineering major. Dual-listing: ME 681.

ME 482. Fuel Cell Science and Engineering. 3 Credits.
Fundamental concepts and technology of state-of-the-art fuel cells and their applications. Prereq: CHEM 121, ME 350 or ME 351 and admission to the program. {Also offered for graduate credit - see ME 682.}.

ME 483. Introduction to Computational Fluid Dynamics. 3 Credits.
Introduction to the methods and analysis techniques used in numerical solutions of fluid flow, heat and mass transfer problems of practical engineering interest. Prereq: ME 352 and admission to the Mechanical Engineering major. {Also offered for graduate credit - see ME 683.}.

ME 484. Gas Turbines. 3 Credits.
Theory and design of gas turbines and components. Prereq: ME 454 and admission to the Mechanical Engineering major. {Also offered for graduate credit - see ME 684.}.

ME 485. Heating, Ventilation and Air Conditioning. 3 Credits.
Application of the basic fundamentals of thermodynamics, heat transfer, and fluid flow to heating, ventilating, and air conditioning. Prereq: ME 352 and admission to the Mechanical Engineering major. {Also offered for graduate credit - see ME 685.}.

ME 486. Nanotechnology and Nanomaterials. 3 Credits.
This course covers principles of nanotechnology, nanomaterials and develops a framework for their understanding. The basic tools of nanotechnology: nanoscale characterization, physics and materials design will be discussed in the context of current technological advances. Prereq or Coreq: Senior standing in Engineering or Sciences. Cross-listed with CE 486. Dual-listing: ME 686.

ME 487. Internal Combustion Engines. 3 Credits.
Theory and practice of power and propulsion engines utilizing gas as a working substance. Study of gas turbines, spark, and compression ignition engines are included along with hybrid systems. Prereq: ME 351 and admission to the Mechanical Engineering major. {Also offered for graduate credit - see ME 687.}.

ME 488. Introduction to Aerodynamics. 3 Credits.
Introductory aerodynamics, aerodynamic characteristics of airfoils, and other components subjected to inviscid-incompressible flows; dynamics of compressible fluids; shock waves, one-dimensional flow, expansion waves in two-dimensional flow, and compressible flow over aerodynamic bodies. Prereq: ME 352 and admission to the Mechanical Engineering major. {Also offered for graduate credit - see ME 688.}.

ME 489. Vehicle Dynamics. 3 Credits.
Fundamental science and engineering underlying the design and operation of vehicles. Use of previous knowledge of statics, kinematics, dynamics, and machine design. Prereq: ME 222 and admission to the Mechanical Engineering major. {Also offered for graduate credit - see ME 689.}.

ME 491. Seminar. 1-5 Credits.

ME 492. Global Practicum: Study Abroad. 1-15 Credits.
Pre-Arranged study at accredited foreign institutions (study abroad), domestic institutions (National Student Exchange) or on approved study abroad programs. Pre-requisite: Sophomore standing and prior approval by International Student and Study Abroad Services and major department. Graded 'P'or 'F' (Undergraduate), or 'S' or 'U' (Graduate).

ME 494. Individual Study. 1-5 Credits.

ME 496. Field Experience. 1-15 Credits.

ME 499. Special Topics. 1-5 Credits.

ME 612. Engineering Measurements. 3 Credits.
Principles and characteristics of instruments used for engineering measurements, statistical analysis of data, signal conditioning, data acquisition systems. Includes laboratory. {Also offered for undergraduate credit - see ME 412.}.

ME 621. Theory of VIbrations. 3 Credits.
Fundamentals of vibrations; free, forced, and damped vibration of single and multiple degrees of freedom systems. {Also offered for undergraduate credit - see ME 421.}.

ME 635. Plastics and Injection Molding Manufacturing. 3 Credits.
Product and process engineering for manufacturers of plastic products; material evaluation and selection, mold design, process design, quality evalutaion of manufactured plastic parts. Cross-listed with IME 635. {Also offered for undergraduate credit - see ME 435.}.

ME 636. Biopolymers and Biocomposites. 3 Credits.
Structure/properties/synthesis of biopolymers, biomaterials and engineered biocomposites derived from plant based materials. An interdisciplinary course designed for graduate students. Introduction to science and engineering of converting biorenewable resources into novel biobased materials and products. Introduction to principles and concepts critical to successful design of polymeric biomaterials, coatings, and biocomposites. Understanding environmental impacts through life cycle analysis (LCA). Restrictions: A junior standing student can register if accepted to an accelerated graduate program. Cross-listed with CHEM 636 and CPM 636. {Also offered for undergraduate credit - See ME 436.}.

ME 637. Engineering Ceramics. 3 Credits.
Study the crystal and defect structures to determine the electrical and mass transport behaviors in ceramic materials. Investigation on microstructure of ceramic materials and its effect on optical, magnetic, dielectic, and thermo-mechanical properties. {Also offered for undergraduate credit - see ME 437.}.

ME 642. Machine Design I. 3 Credits.
Application of engineering mechanics, material properties, and failure theories to the design of reliable machine components. {Also offered for undergraduate credit - see ME 442.}.

ME 643. Machine Design II. 3 Credits.
Application of methods, procedures, and standards used in the design and selection of mechanical components and elements, including springs, roller and journal bearings, gears, brakes, belts and flexible elements. {Also offered for undergraduate credit - see ME 443.}.

ME 654. Heat and Mass Transfer. 3 Credits.
Principles of heat transfer by conduction, convection, and radiation. Introduction to mass transfer principles. {Also offered for undergraduate credit - see ME 454.}.

ME 666. Basic Principles of Unmanned Vehicles. 3 Credits.
This course equips students with basic knowledge of the principles of unmanned ground, air, and underwater vehicles. Students learn engineering principles involved in developing unmanned vehicles, which include locomotion systems, path planning, control, and navigation systems. Dual-listing: ME 466.

ME 668. Introduction to Biomechanics. 3 Credits.
Introduction to the fundamentals of biomechanics including force analysis, mechanics of deformable bodies; stress and strain, transport phenomena, and viscoelasticity, as well as their applications on the biomechanics of soft and hard tissues. {Also offered for undergraduate credit - see ME 468.}.

ME 669. Energy Storage Technology. 3 Credits.
This course will cover the fundamentals of energy storage. It will provide an introduction to the principles of thermal, mechanical, and electrochemical storage technologies. {Also offered for undergraduate credit - see ME 469.}.

ME 670. Renewable Energy Technology. 3 Credits.
Introduction to renewable energy technology, solar thermal energy systems, solar photovoltaic systems, wind turbines; biomass; bio-fuels; urban waste to energy from pyrolysis plants; hydrogen energy and fuel cells. {Also offered for undergraduate credit - see ME 470.}.

ME 671. Experimental Stress Analysis. 3 Credits.
Introduction to experimental techniques for the measurement of stresses and strains, including strain gages, optical methods, photoelasticity, and brittle coatings. {Also offered for undergraduate credit - see ME 471.}.

ME 672. Fatigue and Fracture of Metals. 3 Credits.
Causes and effects of fatigue failure and fracture of metals, analytical methods for fatigue design and fatigue life prediction, fatigue crack initiation and propagation, fatigue testing and validation. {Also offered for undergraduate credit - see ME 472.}.

ME 673. Engineering with Polymeric Materials. 3 Credits.
This course will introduce basic polymer materials including plastics, rubbers, fibers, and adhesives; structures, properties, and their relationships of polymers; additives; processing technologies, applications and development. {Also offered for undergraduate credit - see ME 473.}.

ME 674. Mechanics of Composite Materials. 3 Credits.
Materials, properties, stress, and strength analyses; engineering design and manufacturing aspects of short and continuous fiber-reinforced materials. {Also offered for undergraduate credit - see ME 474.}.

ME 675. Automatic Controls. 3 Credits.
Introduction to industrial automatic controls. Theory and applications of pneumatic control, continuous process control, and programmable logic control. Demonstrations and discussion of the current industrial practice. {Also offered for undergraduate credit - see ME 475.}.

ME 676. Mechatronics. 3 Credits.
Design and development of mechatronic systems that require an integrated knowledge of mechanical engineering, electronics, computer science and control theory. {Also offered for undergraduate credit - see ME 476.}.

ME 677. ME Finite Element Analysis. 3 Credits.
Introduction to the finite element method and its application to problems in mechanical engineering, including stress analysis. {Also offered for undergraduate credit - see ME 477.}.

ME 678. Advanced Flow Diagnostics. 3 Credits.
Introduction and review of fundamentals of advanced thermal and fluid measurement techniques for engineering applications including advanced laser and optical diagnostics, high speed imaging, infrared thermography, fiber optics, fluorescence, etc. {Also offered for undergraduate credit - See ME 478}.

ME 679. Fluid Power Systems Design. 3 Credits.
Fluid dynamics principles and fluid properties are applied to the study of function, performance, and design of system components and systems for power transmission and control purposes. {Also offered for undergraduate credit - see ME 479.}.

ME 680. Biofluid Mechanics. 3 Credits.
Overview of fluid dynamical phenomena in biological systems; flow behavior of fluids in living organisms; application of fluid mechanics to the cardiovascular system and blood circulation. {Also offered for undergraduate credit - see ME 480.}.

ME 681. Fundamentals of Energy Conversion. 3 Credits.
Foundations of the engineering of energy conversion. Introduction to electrical power generating systems and their major components. Concepts and designs in thermodynamic cycles for engineering applications. Dual-listing: ME 481.

ME 682. Fuel Cell Science and Engineering. 3 Credits.
Fundamental concepts and technology of state-of-the-art fuel cells and their applications. {Also offered for undergraduate credit - see ME 482.}.

ME 683. Introduction to Computational Fluid Dynamics. 3 Credits.
Introduction to the methods and analysis techniques used in numerical solutions of fluid flow, heat and mass transfer problems of practical engineering interest. {Also offered for undergraduate credit - see ME 483.}.

ME 684. Gas Turbines. 3 Credits.
Theory and design of gas turbines and components. Prereq: ME 654. {Also offered for undergraduate credit - see ME 484.}.

ME 685. Heating, Ventilation and Air Conditioning. 3 Credits.
Application of the basic fundamentals of thermodynamics, heat transfer, and fluid flow to heating, ventilating, and air conditioning. {Also offered for undergraduate credit - see ME 485.}.

ME 686. Nanotechnology and Nanomaterials. 3 Credits.
This course covers principles of nanotechnology, nanomaterials and develops a framework for their understanding. The basic tools of nanotechnology: nanoscale characterization, physics and materials design will be discussed in the context of current technological advances. {Also offered for undergraduate credit - see ME 486.}.

ME 687. Internal Combustion Engines. 3 Credits.
Theory and practice of power and propulsion engines utilizing gas as a working substance. Study of gas turbines, spark, and compression ignition engines. {Also offered for undergraduate credit - see ME 487.}.

ME 688. Introduction to Aerodynamics. 3 Credits.
Introductory aerodynamics, aerodynamic characteristics of airfoils, and other components subjected to inviscid-incompressible flows; dynamics of compressible fluids; shock waves, one-dimensional flow, expansion waves in two-dimensional flow, and compressible flow over aerodynamic bodies. {Also offered for undergraduate credit - see ME 488.}.

ME 689. Vehicle Dynamics. 3 Credits.
Fundamental science and engineering underlying the design and operation of vehicles. Use of previous knowledge of statics, kinematics, dynamics, and machine design. {Also offered for undergraduate credit - see ME 489.}.

ME 690. Graduate Seminar. 1-3 Credits.

ME 696. Special Topics. 1-5 Credits.

ME 711. Advanced Engineering Analysis. 3 Credits.
Mathematical analysis and numerical treatment of engineering problems, eigenvalue problems in lumped and distributed parameter systems, advanced mathematics applied to engineering design.

ME 712. Advanced Finite Element Analysis. 3 Credits.
Application of finite element methods to problems of plasticity, viscoplasticity, fracture, vibrations, fluids, material and geometric non-linearity, and heat transfer. Recommended: ME 677.

ME 717. Advanced Controls for Mechanical Systems. 3 Credits.
Analysis and design of multivariable control systems for robust stabilization and optimal performance of mechanical systems.

ME 720. Continuum Mechanics. 3 Credits.
Tensor analysis in affined and metric spaces, kinematics of motion, general principles of continuum mechanics and postulates on constitutive laws. Two 75-minute lectures. Cross-listed with CE 720.

ME 721. Advanced Dynamics. 3 Credits.
Newtonian dynamics; dynamics of particles; dynamics of rigid bodies; multi-body dynamics; variational principles; principle of virtual work; d'Alembert's principle; Hamilton's principle; Lagrange's equation of motion; kinematics of rigid bodies; solutions of nonholonomic equations of motion.

ME 722. Advanced Mechanics of Materials. 3 Credits.
Stress, deformation, failure analysis of deformable bodies and structures under static and dynamic loadings, fundamental concepts and definitions in stress, strain, energy methods, plasticity, fracture, fatigue, creep, contact, impact and stability of solid bodies and plate bending problems.

ME 725. Advanced Mechanics and Failure of Composites. 3 Credits.
Concepts in static, dynamics, impact, and thermal analysis of anisotropic elastic materials are covered. Different failure theories, laminated theories, and micromechanics formulations of composites are reviewed in detail.

ME 726. Fracture Mechanics. 3 Credits.
Linear elastic fracture mechanics, energy release rate, stress intensity factor, J-integral, elasto-plastic fracture, crack tip plasticity, crack propagation, fracture fatigue crack growth, fracture tests, fracture in polymers, ceramics and composite materials.

ME 728. Stress Waves in Solids. 3 Credits.
Introduction to fundamental concepts and principles of stress waves propagating in solid materials and relevant applications and experimental techniques.

ME 729. Advanced Vibrations. 3 Credits.
Newton-Euler method; Lagrange's method; frequency response; modal analysis; eigenvalue problems; second-order stiffness systems (rod, shaft and string); Euler-Bernoulli beam theory; Rayleigh beam theory; Timoshenko beam theory; extended operator; membranes.

ME 731. Mechanical Behavior of Materials. 3 Credits.
Fundamental concepts of elastic, viscoelastic, and plastic deformation of materials; emphasizing atomic and microstructure-mechanical property relationships. Theory of static and dynamic dislocations; fracture, fatigue, and creep as well as strengthening mechanisms in materials.

ME 733. Polymer Nanocomposites. 3 Credits.
Fundamental concepts and principles of nanotechnology, nanostructured materials and nanocomposites; polymer nanocomposites processing, property characterization, and relevant modeling.

ME 734. Smart Materials and Structures. 3 Credits.
Physics, chemistry, engineering principles and applications of smart materials and structures. Recommended: Any basic materials science class, solid state physics class, or CPM 672 or CPM 674.

ME 736. Advanced Surface Analysis. 3 Credits.
Topics covered in this course include tribology, introduction to deposition technologies, surface protection mechanisms, surface preparation for deposition, hard coatings, materials science of deposition, analytical techniques for surface characterization, evaluation of mechanical performance of deposited layer, case studies.

ME 743. Biomechanics Of Impact. 3 Credits.
Fundamental sciences of engineering and human anatomy that form the basis of biomechanics of soft tissue and bone under dynamic conditions.

ME 751. Advanced Thermodynamics. 3 Credits.
Rigorous treatment of thermodynamic principles. Emphasis on the concept of availability methods as applied to various engineering systems.

ME 753. Gas Dynamics. 3 Credits.
Fundamental concepts of fluid dynamics and thermodynamics are used in the treatment of compressible flow, frictional flows, and flows with heat transfer or energy release.

ME 754. Viscous Fluid Flow. 3 Credits.
Fundamental laws of motion of a viscous fluid are derived and used in the consideration of laminar boundary layers, transition phenomena, and turbulent boundary layer flows. Prereq or Coreq: Recommended completion of an undergraduate fluid dynamics course (ME 352 equivalent).

ME 755. Fluid Mechanics for Bio/Nanotechnologies. 3 Credits.
Fundamental principles of fluid dynamics in micro and nano scales, with applications to nanotechnology and biotechnology.

ME 761. Advanced Heat Transfer. 3 Credits.
Advanced study of heat conduction and convection. Analytical, graphical, and numerical evaluations of the temperature field. Use of advanced mathematical methods in the solution of boundary value problems. Solutions to laminar and turbulent convective heat transfer problems. Analysis of boiling and condensation Prereq or Coreq: Recommended completion of an undergraduate heat transfer course (ME 454 equivalent).

ME 762. Applied Multimode Heat Transfer. 3 Credits.
The course will expand on the heat transfer concepts covered undergraduate heat transfer courses. The focus is on radiative transfer and applying heat transfer principles to complex, multi-mode heat transfer relevant to current engineering problems.

ME 763. Advanced Transport Phenomena. 3 Credits.
Advanced topics in combined heat, mass and momentum transport, with applications to energy and biomedical systems.

ME 790. Graduate Seminar. 1-3 Credits.

ME 791. Temporary/Trial Topics. 1-5 Credits.

ME 793. Individual Study/Tutorial. 1-5 Credits.

ME 795. Field Experience. 1-15 Credits.

ME 796. Special Topics. 1-5 Credits.

ME 797. Master's Paper. 1-3 Credits.

ME 798. Master's Thesis. 1-10 Credits.

ME 892. Graduate Teaching Experience. 1-6 Credits.

ME 898. Continuing Enrollment. 1-9 Credits.
For graduate students who have completed all necessary credits of course work including thesis (798) and dissertation (899) on their approved Plan of Study, but who have not yet completed and submitted their thesis or dissertation. This course does not count towards the credit requirements for the degree and is not financial aid eligible. Department consent required to enroll.

ME 899. Doctoral Dissertation. 1-15 Credits.