ME-Mechanical Engineering

ME 511. Intermediate Fluid Mechanics. 3 Hours.
Applications of fluid dynamic principles to engineering flow problems such as turbo-machinery flow and one-dimensional compressible flow. Vorticity, potential flow, viscous flow, Navier-Stokes solutions, and boundary layers. Introduction to Fluid Mechanics or equivalent is a recommended prerequisite for this course.

ME 521. Introduction to Computational Fluid Dynamics Basics. 3 Hours.
Governing equations for fluid flows, classifications of flow regimes, and approaches to analyze fluid flow problems. Introduction to Computational Fluid Dynamics (CFD), mesh generation, boundary conditions, numerical solution of equations governing fluid flows, and visualization. Hands-on exercises using a commercial CFD solver.

ME 530. Vehicular Dynamics. 3 Hours.
Introduction to the fundamentals of mechanics and analytical methods for modeling vehicle dynamics and performance. Topics include tire-road interaction modeling, vehicle longitudinal dynamics and traction performance, lateral dynamics, handling, stability of motion and rollover, as well as, contribution of the drivetrain system, steering system and suspension configurations to the dynamics of a vehicle. Software applications, projects, and exposure to hardware and systems are used to reinforce concepts. Dynamics or equivalent is a recommended prerequisite for this course.

ME 531. Introduction to Vehicle Drive Systems Engineering. 3 Hours.
Engineering fundamentals of mechanical and mechatronic, hybrid-electric, and electric drive systems. Applications to passenger cars and commercial vehicles. Drive system and component design, including main clutches and torque converters, transmissions, transfer cases, and drive axles. Introduction to plug-in hybrid-electric vehicles. Students registering for this course should have successfully completed (grade C or better) ME 215 Dynamics and ME 370 Kinematics and Dynamics of Machinery or equivalents.
Prerequisites: ME 215 [Min Grade: C] and ME 370 [Min Grade: C](Can be taken Concurrently)

ME 532. Introduction to Electric Vehicles. 3 Hours.
Introduction to fully electric and hybrid vehicle engineering. Mechatronic system and component design. Batteries and energy storage devices. Plug-in hybrid electric vehicles.

ME 545. Combustion. 3 Hours.
Evaluation of the impact of fuel characteristics and operating conditions on the performance of coal-fired electric utility steam-raising plant and the prospects for continued reliance on coal as fuel for electric power generation. The phenomena emphasized are the behavior of turbulent jets; ignition, devolatilization and combustion of coal particles; radiative heat transfer and the effect of ash deposits on heat transfer; formation of air pollutants and their removal from combustion products; integrated gasification combined cycle; and capture and sequestration of carbon dioxide. Thermodynamics II, Introduction to Fluid Mechanics, and Introduction to Heat Transfer or equivalents are recommended prerequisites for this course.

ME 547. Internal Combustion Engines. 3 Hours.
Fundamentals of reciprocating internal combustion engines: engine types, engine components, engine design and operating parameters, thermochemistry of fuel-air mixtures, properties of working fluids, ideal models of engine cycles, engine operating characteristics, gas-exchange processes, fuel metering, charge motion within the cylinder, combustion in spark-ignition and compression ignition engines.

ME 549. Power Generation. 3 Hours.
Application of thermodynamics, fluid mechanics, and heat transfer to conversion of useful energy. Includes terrestrial and thermodynamic limitations, fossil fuel power plants, renewable energy sources, and direct energy direct energy conversion. Thermodynamics II or equivalent is a recommended prerequisite for this course.

ME 554. Heating, Ventilating, & AC. 3 Hours.
Fundamentals and practice associated with heating, ventilating, and air conditioning; study of heat and moisture flow in structures, energy consumption, and design of practical systems. Introduction to Heat Transfer or equivalent is a recommended prerequisite for this course.

ME 555. Thermal-Fluid Systems Design. 3 Hours.
Comprehensive design problems requiring engineering decisions and code/Standard compliance. Emphasis on energy system components: piping networks, pumps, heat exchangers. Includes fluid transients and system modeling. Introduction to Heat Transfer is a recommended prerequisite for this course.

ME 556. Building Energy Modeling and Analysis. 3 Hours.
Computer modeling of energy use and thermal comfort in buildings using several software tools. Interpretation and analysis of the results. Implementing energy efficiency measures in the model and studying the effects on energy use. Students registering for this course should have successfully completed (grade of C or better) ME 242 Thermodynamics II and ME 322 Introduction to Heat Transfer or equivalents.

ME 564. Introduction to Finite Element Method. 3 Hours.
Concepts and applications of finite element method. Development and applications of basic elements used in engineering mechanics. Use of finite element analysis software. Application of finite element concept to several areas of mechanics. Mechanics of Solids or equivalent is a recommended prerequisite for this course.

ME 575. Mechanical Vibrations. 3 Hours.
Development of equations of motion for free and forced single-degree-of-freedom (SDOF) systems. Multi-degree-of-freedom systems. Transient response, support motion and vibration isolation for SDOFs. Vibration absorbers, generalized mass and stiffness, orthogonality of normal modes, and root solving and Gauss elimination procedures. Chelosky decomposition and Jacobi diagonalization methods.

ME 577. Systems Engineering. 3 Hours.
Exposure to the field of systems engineering, mission design, requirements development, trade studies, project life cycle, system hierarchy, risk analysis, cost analysis, team organization, design fundamentals, work ethics, compare and evaluate engineering alternatives, systems thinking.

ME 578. Automated Manufacturing. 3 Hours.
Introduction to automated manufacturing technology. Components of automated systems (controllers, sensors and actuators) and automated manufacturing sub-systems (3D printer, CNC, robot and computer vision) will be studied in a lecture\lab environment with hands on activities. A basic understanding of engineering graphics and computer methods at the undergraduate level is required for this course.

ME 580. Instrumentation and Measurements. 3 Hours.
Thorough exploration of fundamental measurement concepts and techniques for data acquisition and validation. Explanation of important selection criteria for the identification and configuration of commercially available data acquisition devices. Students will get hands on experience following best practices for data acquisition (high speed vs low speed) relevant to their field of study or career. Many types of sensors, their underlying technology, and measurement techniques will be discussed (i.e. accelerometers, load cells, Digital Image Correlation, etc.) to demonstrate best practices for sensor selection for a wide range of specialized applications.

ME 590. Special Topics in Mechanical Engineering. 1-3 Hour.
Special Topics in Mechanical Engineering.

ME 591. Individual Study in Mechanical Engineering. 1-6 Hour.
Individual Study in Mechanical Engineering.

ME 611. Advanced Fluid Mechanics. 3 Hours.
Fundamental laws of motion for viscous fluid, classical solutions of the Navier-Stokes equations, inviscid flow solutions, laminar boundary layers, and stability criteria.

ME 613. Introduction to Computational Fluid Dynamics. 3 Hours.
Review of governing equations of fluid dynamics, mathematical behavior of partial differential equations, basic aspects of discretization, basic CFD techniques, basic grid generation, coordinate transformations, advanced numerical schemes, future CFD methodology. A knowledge of a computer language is required.

ME 614. Advanced Computational Fluid Dynamics. 3 Hours.
Finite Volume Scheme, Eigenvalues and Eigenvectors, Method of Characteristics, Upwind Schemes, Flux Vector Splitting, Flux Difference Splitting, Explicit and Implicit Schemes, Flux Jacobians, Newton Method, Boundary Conditions, Weak Solutions, TVD, PISO Methods.

ME 615. Introduction to Turbulent Flows. 3 Hours.
Characteristics of turbulence, length and time scales, energy cascade, vorticity stretching, Reynolds averaging technique, Closure problem, Boussinesq hypothesis, Eddy viscosity concepts, introduction to zero-, one-, and two-equation models, Reynolds stress model.

ME 631. Dynammics and Mobility of Vehicles: Modeling and Simulation. 3 Hours.
The main goal of the course is to present advanced research and engineering knowledge in recent vehicle dynamics of road and off-road wheeled and track vehicles with an emphasis on vehicle longitudinal/lateral mobility and energy efficiency. Applications include vehicles for personal transportation, military vehicles, construction equipment and farm tractors. A unique feature of this course is its inverse vehicle dynamics approach. Another distinctive feature of the course is a mechatronics-based approach to modeling and simulation of multi-domain systems that include mechanical, electrical and electronics components such as sensors and actuators. Coupled and interactive dynamics of vehicle systems is presented, and a modeling process of vehicle operational properties is based on various equations of analytical and adaptive dynamics. Students will gain knowledge and analytical hands-on skills through innovative homework and a research project. Skills in one of programming software/languages are required (e.g., MATLAB/Simulink, ADAMS/Car, LabVIEW, etc.).

ME 632. Autonomous Wheel Power Management Systems: Theory and Design. 3 Hours.
The main goal of this course is to give detailed understanding, analytical knowledge and engineering experience in research, design and experimental study of autonomous wheel power management systems (AWPMS). The AWPMS are autonomous mechatronic and autonomously operated mechanical systems that distribute power among the drive wheels of vehicles. AWPMS include various configurations of torque vectoring systems, limited slip differentials and hydraulically controlled differentials, electronically-locking differentials, and positive engagement of the wheels. AWPMS that are operationally integrated with steering and suspension systems are also presented in the course. Characteristics of wheel power management systems for a specific vehicle application are proved in the course by using inverse vehicle dynamics formulation and requirements to vehicle energy efficiency, mobility, stability of motion, and turnability. Students will learn mechanical design principles for mechatronic systems and methods for developing control algorithms. Methods for experimental study of wheel power management systems and vehicles are also presented in the course; including 4x4 vehicle chassis dynamometer with individual wheel control and test setups. Students will exercise analytical skills and gain hands-on experience through innovative homework and a research project.

ME 640. Heat Conduction. 3 Hours.
Introduction to methods of solution for heat conduction problems. Topics include separation of variables in rectangular, cylindrical and spherical coordinates, solution to the heat equation on semi-infinite and infinite domains, Duhamel's Theorem, use of Green's Function, and use of the Laplace Transform. A basic understanding of heat transfer at the undergraduate level is required for this course.

ME 641. Radiation Heat Transfer. 3 Hours.
Introduction to radiation heat transfer. Topics include radiation from black bodies and nonblack opaque surfaces, configuration factors for diffuse surfaces, radiation exchange in enclosures of diffuse-grey and specularly reflecting surfaces, radiation combined with conduction and convection, and energy transfer for absorbing, emitting and scattering media. A basic understanding of heat transfer at the undergraduate level is required for this course.

ME 650. Transport Phenomena. 3 Hours.
Laminar flow transports: momentum transfer (Couette/Poiseuille flows), energy transfer (free/forced convections and conductions), and mass transfer; equation of state, turbulence, chemical reactions, and numerical methods solving transport equations. Introduction to Fluid Mechanics and Introduction to Heat Transfer or equivalents are recommended prerequisites for this course.

ME 661. Math Methods in EGR I. 3 Hours.
Mathematical theory and solutions methods to problems in engineering including advanced ordinary differential equations; euigenvalue problems; multi-variable calculus and implicit functions; curve, surface ad volume representation and integration; Fourier integrals and transforms; separation of variables and transform techniques for solution of partial differential equations. Differential Equiations or equivalent is recommended as a prerequisite for this course.

ME 662. Math Methods in EGR II. 3 Hours.
Mathematical theory and solution methods to problems in engineering including Scalar and vector field theory advanced partial differential equations, analysis using complex variables, conformal mapping, complex integral calculus, Green's functions, perturbation methods, and variational calculus. Math Methods in EGR I or equivalent is recommended as a prerequisite for this course.

ME 663. Engineering Statistics. 2 Hours.
Introduction to applied statistics and probability for engineering and the physical sciences. Topics include introduction to probability, discrete and random variables and their distributions, joint probability distributions, hypothesis testing, statistical inference, linear regression and correlation, design of experiments, and statistical quality control. A basic understanding of calculus and matrix algebra at the undergraduate level is required for this course.

ME 665. Computational Methods in EGR. 3 Hours.
Applications of computers to solution of problems in engineering, including matrices, roots of equations, solution of simultaneous equations, curve fitting by least squares, differentiation and integration, differential and partial differential equations. Differential Equations and Computational Engineering or equivalents are recommended prerequisites for this course.

ME 670. Intro to Continuum Mechanics. 3 Hours.
Fundamentals and application of mechanics principles to problems in continuous media. Matrix and tensor mathematics, fundamentals of stress, kinematics and deformation of motion, conservation equations, constitutive equations and invariance, linear and nonlinear elasticity, classical fluids, linear viscoelasticity. Mechanics of Solids and Differential Equations or equivalents are recommended prerequisites for this course.

ME 672. Advanced Dynamics. 3 Hours.
Advanced topics in dynamics including complex motion analysis, generalized kinematic parameters, quasivelocities, and virtual displacements, direct and inverse dynamics approach, and fundamentals of systems with variable masses. Introduction to the modeling of mechatronic systems is presented through a consideration of mechanical,electrical and electronics components. Analytical and adaptive dynamics principles are taught as a basis for control algorithm development and mechatronic system design.

ME 675. Mechanics of Plates and Shells. 3 Hours.
Equations of motion from classical Kirchoff plate theory, with solutions for cylindrical bending, buckling, and natural vibration of plate strips, rectangular plates and circular plates. Navier, Levy and Rayleigh-Ritz solutions for rectangular plates under various boundary conditions. First and third order shear deformation plate theories with analytical and numerical solutions. Finite element models based on both classical and shear deformation plate theories.

ME 679. Advanced Finite Element Analysis. 3 Hours.
Concepts and applications of finite element method. Development and applications of various elements used in engineering mechanics. Use of finite element analysis software. Application of finite element concept and model development to fluid, heat transfer, and solid mechanics problems. Introduction to Fluid Mechanics, Introduction to Heat Transfer, and Mechanics of Solids or equivalents are recommended prerequisites for this course.

ME 688. Fluid-Structure Interactions. 3 Hours.
Modeling and simulation of fluid-structure interaction (FSI) phenomena using computational methods. The Arbitrary Lagrangian Euleriean (ALE) formulation, a variety of interpolation methods, mesh movement and time mapping algorithms. Solution of FSI problems using interface codes.

ME 690. Special Topics in (Area). 1-6 Hour.
Special Topics in (Area).

ME 691. Individual Study in (Area). 1-6 Hour.
Individual Study In (Area).

ME 698. Non-Thesis Research. 1-12 Hour.

ME 699. Thesis Research. 1-12 Hour.
Prerequisites: GAC M

ME 711. Advanced Fluid Mechanics. 3 Hours.
Fundamental laws of motion for viscous fluid, classical solutions of the Navier-Stokes equations, inviscid flow solutions, laminar boundary layers, and stability criteria.

ME 713. Introduction to Computational Fluid Dynamics. 3 Hours.
Review of governing equations of fluid dynamics, mathematical behavior of partial differential equations, basic aspects of discretrization, basic CFD techniques, basic grid generation, coordinate transformation, advanced numerical schemes, future CFD methodology. A knowledge of a computer language is required.

ME 714. Advanced Computational Fluid Dynamics. 3 Hours.
Finite Volume Scheme, Eigenvalues and Eigenvectors, Method of Characteristics, Upwind Schemes, Flux Vector Splitting, Flux Difference Splitting, Explicit and Implicit Schemes, Flux Jacobians. Newton Method, Boundary Conditions, Weak Solutions, TVD, PISD Methods.

ME 715. Introduction to Turbulent Flows. 3 Hours.
Characteristics of turbulence, length and time scales, energy cascade, vorticity stretching, Reynolds averaging techniques. Closure problem, Boussinesq hypothesis, Eddy viscosity concepts, introduction to zero-, one-and two-equation models, Reynolds stress model.

ME 731. Dynamics and Mobility in Vehicles: Modeling and Simulation. 3 Hours.
The main goal of the course is to present advanced research and engineering knowledge in recent vehicle dynamics of road and off-road wheeled and track vehicles with an emphasis on vehicle longitudinal/ lateral mobility and energy efficiency. Applications include vehicles for personal transportation, military vehicles, construction equipment and farm tractors. A unique feature of this course is its inverse vehicle dynamics approach. Another distinctive feature of the course is a mechatronics-based approach to modeling and simulation of multi-domain systems that include mechanical, electrical and electronics components such as sensors and actuators. Coupled and interactive dynamics of vehicle systems is presented, and a modeling process of vehicle operational properties is based on various equations of analytical and adaptive dynamics. Students will gain knowledge and analytical hands-on skills through innovative homework and a research project. Skills in one of programming software/languages are required (e.g., MATLAB/Simulink, ADAMS/Car, LabVIEW, etc.).

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The main goal of this course is to give detailed understanding, analytical knowledge and engineering experience in research, design and experimental study of autonomous wheel power management systems (AWPMS). The AWPMS are autonomous mechatronic and autonomously operated mechanical systems that distribute power among the drive wheels of vehicles. AWPMS include various configurations of torque vectoring systems, limited slip differentials and hydraulically controlled differentials, electronically-locking differentials, and positive engagement of the wheels. AWPMS that are operationally integrated with steering and suspension systems are also presented in the course. Characteristics of wheel power management systems for a specific vehicle application are proved in the course by using inverse vehicle dynamics formulation and requirements to vehicle energy efficiency, mobility, stability of motion, and turnability. Students will learn mechanical design principles for mechatronic systems and methods for developing control algorithms. Methods for experimental study of wheel power management systems and vehicles are also presented in the course; including 4x4 vehicle chassis dynamometer with individual wheel control and test setups. Students will exercise analytical skills and gain hands-on experience through innovative homework and a research project.

ME 740. Heat Conduction. 3 Hours.
Introduction to methods of solution for heat conduction problems. Topics include separation of variables in rectangular, cylindrical and spherical coordinates, solution to the heat equation on semi-infinite and infinite domains, Duhamel's Theorem, use of Green's Function, and use of the Laplace Transform. A basic understanding of heat transfer at the undergraduate level is required for this course.

ME 741. Radiation Heat Transfer. 3 Hours.
Introduction to radiation heat transfer. Topics include radiation from black bodies and nonblack opaque surfaces, configuration factors for diffuse surfaces, radiation exchange in enclosures of diffuse-grey and specularly reflecting surfaces, radiation combined with conduction and convection, and energy transfer for absorbing, emitting and scattering media. A basic understanding of heat transfer at the undergraduate level is required for this course.

ME 750. Transport Phenomena. 3 Hours.
Laminar flow transports: momentum transfer (Couette/Poiseuille flows), energy transfer (free/forced convections and conductions), and mass transfer; equation of state, turbulence, chemical reactions, and numerical methods solving transport equations.

ME 761. Math Methods in EGR I. 3 Hours.
Mathematical theory and solutions methods to problems in engineering including advanced ordinary differential equations; euigenvalue problems; multi-variable calculus and implicit functions; curve, surface ad volume representation and integration; Fourier integrals and transforms; separation of variables and trsnform techniques for solution of partial differential equations. Differential Equiations or equivalent is recommended as a prerequisite for this course.

ME 762. Math Methods in EGR II. 3 Hours.
Mathematical theory and solution methods to problems in engineering including Scalar and vector field theory advanced partial differential equations, analysis using complex variables, conformal mapping, complex integral calculus, Green's functions, perturbation methods, and variational calculus. Math Methods in EGR I or equivalent is a recommended prerequistie for this course.

ME 763. Engineering Statistics. 3 Hours.
Introduction to applied statistics and probability for engineering and the physical sciences. Topics include introduction to probability, discrete and random variables and their distributions, joint probability distributions, hypothesis testing, statistical inference, linear regression and correlation, design of experiments, and statistical quality control. A basic understanding of calculus and matrix algebra at the undergraduate level is required for this course.

ME 765. Computational Methods in EGR. 3 Hours.
Applications of computers to solution of problems in engineering, including matrices, roots of equations, solution of simultaneous equations, curve fitting by least squares, differentiation and integration, differential and partial differential equations. Differential Equations and Computational Engineering or equivalents are recommended prerequisites for this course.

ME 770. Intro to Continuum Mechanics. 3 Hours.
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ME 772. Advanced Dynamics. 3 Hours.
Advanced topics in dynamics including complex motion analysis, generalized kinematic parameters, quasivelocities and virtual displacements, direct and inverse dynamics approaches, and fundamentals of systems with variable masses. Introduction to the modeling of mechatronic systems is presented through a consideration of mechanical, electrical, and electronics components. Analytical and adaptive dynamics principles are taught as a basis for control algorithm development and mechatronic system design. Students are expected to have a working knowledge of dynamics prior to registering for this course.

ME 775. Mechanics of Plates and Shells. 3 Hours.
Equations of motion from classical Kirchoff plate theory, with solutions for cylindrical bending, buckling, and natural vibration of plate strips, rectangular plates and circular plates. Navier, Levy and Rayleigh-Ritz solutions for rectangular plates under various boundary conditions. First and third order shear deformation plate theories with analytical and numerical solutions. Finite element models based on both classical and shear deformation plate theories.

ME 779. Advanced Finite Element Analysis. 3 Hours.
Concepts and applications of finite element method. Development and applications of various elements used in engineering mechanics. Use of finite element analysis software. Application of finite element concept and model development to fluid, heat transfer, and solid mechanics problems. Introduction to Fluid Mechanics, Introduction to Heat Transfer, and Mechanics of Solids or equivalents are recommended prerequisites for this course.

ME 788. Fluid-Structure Interactions. 3 Hours.
Modeling and simulation of fluid-structure interaction (FSI) phenomena using computational methods. The Arbitrary Lagrangian Euleriean (ALE) formulation, a variety of interpolation methods, mesh movement and time mapping algorithms. Solution of FSI problems using interface codes.

ME 790. Special Topics in ME. 1-6 Hour.
Special Topics in (Area).

ME 791. Individual Study in (Area). 1-6 Hour.
Individual Study in (Area).

ME 796. IEGR Journal Club. 1 Hour.
Journal club to discuss current research and investigations in areas of interdisciplinary engineering.

ME 798. Non-Dissertation Research. 1-12 Hour.
Research.

ME 799. Dissertation Research. 1-12 Hour.
Research.
Prerequisites: GAC Z