

Mechanical Engineering

Degree Offered:	Master of Science in Mechanical Engineering
Website:	https://www.uab.edu/engineering/mme/graduate/ms-mechanical
Director:	David Littlefield, PhD
Phone:	(205) 975-5882
E-mail:	littlefield@uab.edu

Mechanical engineering is a broad-based discipline, and graduate students will have opportunities to explore a number of research areas where they will work alongside nationally and internationally known faculty mentors. The ME department offers a Master of Science in Mechanical Engineering degree, including both Thesis and Non-Thesis options.

Additional Information

Deadline for Entry Term(s):	Fall: August 1; Spring: December 1; Summer: May 1
Deadline for All Application Materials to be in the Graduate School Office:	Six weeks before term begins

Master of Science in Mechanical Engineering Admissions Requirements

- A bachelor's degree from an accredited (or equivalent) program in engineering or the physical sciences is required for admission to graduate study in mechanical engineering with not less than B-level scholarship overall or over the last 60 semester hours of earned credit.
- International applicants must submit English proficiency scores in accordance with UAB Graduate School requirement. [Click here for details](#)
- Original transcripts from all colleges and universities attended since high school must be sent directly to the UAB Graduate School (detailed instructions are included during the online application process)

A student with an undergraduate degree in a field of engineering other than mechanical or in the physical sciences may also be accepted into the mechanical engineering program. However, such a student will normally have to take additional, preparatory coursework as part of an expanded plan of study (see "Preparatory Courses" later in this section).

Special Topics (590/690/790) courses and Independent Study (591/691/791) courses are reviewed for degree applicability for each program in the School of Engineering. No more than 6 combined hours of Special Topics and/or Independent Study courses will be applied to the degree without appeal to and approval from the Program Director.

The School of Engineering offers similar courses at the 400/500 and 600/700 levels. While the higher numbered course has more advanced content, there is a significant overlap in topics. Therefore, students are not allowed to take a 500-level or 700-level course for credit if they have previously taken the related 400-level or 600-level course, respectively.

UAB offers Accelerated Bachelor's / Master's and Early Acceptance. To learn more about these programs, including requirements and how to apply, visit the [Graduate School's ALO page](#).

Accelerated Bachelor's / Master's

Mechanical Engineering offers an accelerated Bachelor's / Master's (ABM) option for high-achieving undergraduate students pursuing a BS degree in Mechanical Engineering at UAB. The following courses are approved for shared credit for students pursuing an ABM in ME. A successful graduate of ABM will earn both a bachelor's degree and a master's degree in ME from the University of Alabama at Birmingham in an accelerated time-frame compared to the independent completion of the two degrees.

Graduate courses allowed for credit sharing are: ME 511, ME 521, ME 530, ME 531, ME 532, ME 545, ME 547, ME 549, ME 554, ME 555, ME 556, ME 564, ME 575, ME 577, ME 578, ME 580.

Plan I (Thesis Option)

1. Upon admission to the program, the Graduate Program Director will advise the student on courses for the first semester. During the first semester, the student will be assigned a Committee Chair, based on research interest, who will assist the student in forming their graduate study committee. The committee will consist of the Chair and two graduate faculty members with experience or expertise related to the student's thesis topic. The Chair, in coordination with the committee, will aid the student in course selection.
2. In addition to the general Graduate School requirements, the student must successfully complete at least 24 semester hours of coursework, including:
 - 6 semester hours in committee-approved mathematics courses
 - 18 semester hours in committee-approved mechanical engineering courses or approved related courses, including at least 2 semester hours of MME 601 Mechanical and Materials Engineering Seminar and 3 semester hours in a course outside the student's research or specialization area.
3. A student is eligible for admission to candidacy after (1) a written thesis has been orally presented to and approved by the committee and (2) successful completion of [Responsible Conduct in Research](#) training.
4. After admission to candidacy, the student must register for at least 6 hours of ME 699 Thesis Research in addition to the 24 semester hours of coursework.
5. The student must successfully complete and defend a thesis.

Plan II (Non-thesis Option)

Generally, Plan II will be approved for students working full-time and attending UAB on a part-time basis or when the student demonstrates that Plan II offers superior educational benefits. After 15 credit hours of coursework are completed, the student should select a project director and begin work on the final project. The election of Plan II must be approved by the student's graduate advisor.

1. The student must successfully complete at least 33 semester hours of coursework, including:
 - 6 semester hours in approved mathematics courses
 - A minimum of 27 semester hours in approved mechanical engineering courses or approved related courses. Of these 27 semester hours, students must enroll in:

- at least 3 semester hours in a course outside the student's research or specialization area
 - at least 2 semester hours of MME 601 Mechanical and Materials Engineering Seminar
 - at least 3 hours of ME 698 Non-Thesis Research involving design or research
2. The student must make a presentation on the research project and submit a final report which must be approved by the project director.

Early Acceptance

Early Acceptance Programs are designed for academically superior high school students. Early Acceptance Programs allow high-achieving students to be conditionally admitted into a graduate program at the same time they are admitted to an undergraduate program.

Eligible students are required to maintain a 3.50 undergraduate GPA and complete the following prerequisite courses: ME 241, ME 321, ME 364, and ME 371.

Preparatory Courses

The following courses and their prerequisites are required preparation for the graduate program in mechanical engineering. Students will be required to successfully complete the courses below or present equivalent prior coursework. Additional courses may be required depending on the research interest.

Requirements		Hours
ME 241	Thermodynamics I	3
ME 321	Introduction to Fluid Mechanics	3
ME 322	Introduction to Heat Transfer	3
ME 360	Introduction to Mechatronic Systems Engineering	3
ME 370	Kinematics and Dynamics of Machinery	3
ME 371	Machine Design	3
CE 220	Mechanics of Solids	3

Degree Offered	Mechanical Engineering PhD
Website	https://www.uab.edu/engineering/mme/graduate/phd-mechanical-engineering
Program Director	David L. Littlefield, PhD
Email	littlefield@uab.edu

Program Objectives

The PhD in Mechanical Engineering degree program prepares students to become productive engineering researchers in industry, academia, government, or other organizations. Students will be equipped with the skills necessary to define, formulate and solve novel problems in the mechanical engineering field. The program emphasizes the mechanical engineering sciences with a strong foundation in mathematics. Graduates will be well prepared for research roles to serve their organizations, their communities, and contribute to the UAB mission of having an economic impact in the region.

Graduates will be well prepared for positions as academic, government and industrial researchers. They will be equipped with the knowledge and skills to develop quality research proposals and carry out research to develop new and innovative theories, models, products and ideas in mechanical engineering intended to advance the state-of-the-art. Entry-level roles at academic institutions would include assistant professor or research engineer, and in government and industry research engineer or

laboratory associate. Graduates will also be well prepared to compete for post-doctoral studies at other universities and laboratories across the world.

Students in the Mechanical Engineering PhD program will:

- Develop the ability to identify, formulate and solve complex Mechanical Engineering problems by applying principles of engineering, science and mathematics.
- Be able to explain experimental/theoretical approaches and limitations associated with his/her dissertation project.
- Be able to summarize the relevant literature, identify its limitations, and formulate an original research plan.
- Be able to communicate and defend his/her research results and conclusions in oral and written form.

Admission Requirements

Admission decisions are made on the basis of prior education, GPA, test scores, personal statement, professional experience, and recommendations.

In addition to the Graduate School admission requirements, admission to the Mechanical Engineering PhD program includes the following:

- Undergraduate or graduate degree in Mechanical Engineering or related engineering field from an ABET (or equivalent) accredited program. Applicants who do not meet this criterion but who have an outstanding academic record in a related field outside of engineering may be admitted, but will be required to complete a sequence of undergraduate courses (including prerequisites as appropriate) in addition to the normal requirements of the ME PhD degree
- Minimum GPA of 3.0 on a 4.0 scale for most recent degree
- GRE is not required
- Personal statement identifying research interest
- CV/Résumé
- 3 academic or professional recommendations
- International applicants must submit English proficiency scores in accordance with UAB Graduate School requirement. [Click here for details](#)
- Original transcripts from all colleges and universities attended since high school must be sent directly to the UAB Graduate School (detailed instructions are included during the online application process);

Entry Term	Deadline
Deadline for Entry Term(s)	Fall: August 1; Spring: December 1; Summer: May 1
Deadline for All Application Materials to be in the Graduate School Office	Seven days before term begins

Degree Requirements

Graduate Committee

The graduate study committee (dissertation committee) is an important part of the student's program. The committee will oversee the selection of courses and direction of research. Students must form a graduate committee within the first year of study and must meet with the committee no less than once per academic year. Committees must have at least five members. A minimum of three committee members must have a

primary appointment in the School of Engineering. It is recommended that at least one committee member have an appointment outside of the engineering field.

Coursework

The ME PhD promotes a research-based curriculum with a set of core courses required of all students in the program. Additional coursework is directed by the student's graduate study committee based on the student's area of interest.

Students entering the PhD program with a baccalaureate degree must, in keeping with UAB Graduate School policies, complete at least 48 hours of coursework prior to admission to candidacy. Up to 16 of the 48 credits can be non-dissertation research, and up to 10 credits can be a combination of laboratory rotations, seminars, and directed study.

Students entering the PhD program with a Master's degree in ME or a related field must complete at least 27 credit hours of coursework prior to candidacy. Up to 6 credits of the 27 can be non-dissertation research credits, and up to 6 credits can be as lab rotations, seminars, or directed study credits.

For all students, at least 24 hours of dissertation research are required and must be taken over at least two semesters after admission to candidacy.

Curriculum

Requirements	Hours
Requirements	
GRD 717 Principles of Scientific Integrity	3
ME 661 Math Methods in EGR I	3
ME 662 Math Methods in EGR II	3
ME 799 Dissertation Research (Program Electives) ²	24
MME 601 Mechanical and Materials Engineering Seminar	1
Program Electives ^{3, 4}	35
Total Hours	69

¹ 4 enrollments of 1 hour each; Students may substitute a different graduate-level seminar/journal club with permission of his/her faculty mentor and the program director

² Dissertation hours must be taken over a minimum of 2 terms

³ Elective options include: ME 511, ME 521, ME 530, ME 531, ME 547, ME 575, ME 580, ME 611, ME 613, ME 614, ME 615, ME 650, ME 665, ME 670, ME 672, ME 677, ME 679, ME 688, ME 731, ME 732, ASEM 610, ASEM 611, ASEM 612, ASEM 613, ASEM 615, ASEM 617, ASEM 628, MSE 635

⁴ Students who have earned a Master of Science in Mechanical Engineering are required to successfully complete 14 credit hours of electives from the list above

In addition to the ME PhD program core courses (above), course selection is based on the research and career goals of the student, and curricula will vary between students. Students are guided by their faculty mentor (committee chair) and a graduate study committee composed of faculty representing a transdisciplinary team in the student's area of research interest. Non-dissertation research and dissertation research hours will be taken through the department of the student's faculty mentor.

Specifics of coursework would be tailored to the individual research thrusts of the student and may differ from the lists given below. While

no formal options/concentrations are listed as part of the program, the specifics of the student's curriculum (beyond the core requirements) will be tailored to the individual. Please contact the program director for more information about specific areas of specialization.

Courses

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. Dynamics 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 Equations 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 Eulerian (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 discretization, 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.).

ME 732. 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 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; eigenvalue problems; multi-variable calculus and implicit functions; curve, surface and volume representation and integration; Fourier integrals and transforms; separation of variables and transform techniques for solution of partial differential equations. Differential Equations 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 prerequisite 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.

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 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 Eulerian (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