

# MECHANICAL AND AEROSPACE ENGINEERING (MAE)

---

**MAE 100. Introduction to Mechanical and Aerospace Engineering. 3 Credit Hours.**

Basic principles of automobile engines and engine efficiency. Introduction to robots and controls. Basic concepts of solar engineering and solar energy utilization. Principles of fuel cells and hydrogen energy. Introduction to aerospace engineering including the aspects of aerodynamics, propulsion and flight dynamics. Introduction to Aerodynamics of air planes and rockets.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Summer.

**MAE 111. Introduction to Engineering I. 3 Credit Hours.**

Use of engineering tools and computer techniques for problem solving. Data acquisition, analysis, presentation, software design, and computer aided drafting are covered. Development of design skills through several design and building competitions. Introduction to professional ethics and intellectual property rights. Introduction to use of MATLAB, AutoCAD, and programming in C++.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**MAE 112. Introduction to Engineering II. 2 Credit Hours.**

Introduction to engineering design and the design process. Course topics include safety, reliability, human and environmental factors, economic analysis, and cost estimation. Professional ethics, product liability, solid modeling, machine shop orientation, and practice are also included. Group design projects.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**MAE 202. Dynamics. 3 Credit Hours.**

Discussion of motion description and analysis, application of Newton's laws, energy, and momentum principles to mechanical systems. Introduction to mechanical vibrations. Corequisite: PHY 205.

Prerequisite: CAE 210.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**MAE 207. Mechanics of Solids II. 3 Credit Hours.**

Discussion of displacements, instability, flexural, shear, torsional, and principle stresses. Introduction to statically indeterminate analysis.

Prerequisite: CAE 210.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**MAE 241. Measurements Laboratory. 3 Credit Hours.**

Introduction to experimental mechanical engineering. Basic principles of measurement, data interpretation, and uncertainty analysis are covered. Laboratory exercises in mechanical engineering areas are included.

Prerequisite: IEN 311 And ENG 107 Or Corequisite: MAE 207.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**MAE 301. Engineering Materials Science. 3 Credit Hours.**

Introduction to the physics and chemistry of the solid state including the structure and properties of metals, polymers, and ceramics. Corequisite: PHY 207.

Prerequisite: PHY 223 (207).

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 302. Mechanical Behavior of Materials. 3 Credit Hours.**

Application of metallurgy and mechanics to the study of the plastic deformation and fracture of metals, ceramics, and plastics.

Prerequisite: MAE 207.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**MAE 303. Thermodynamics. 3 Credit Hours.**

Thermodynamic properties of materials; the first and second laws of thermodynamics; application to thermodynamic processes; introduction to heat transfer.

Prerequisite: PHY 222 (206) and MTH 162 or MTH 172.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**MAE 309. Fluid Mechanics. 3 Credit Hours.**

Course topics include fluid statics, fluid flow concepts, dynamics of inviscid and viscous fluids, closed and open channel flow, and compressibility effects.

Prerequisite: CAE 210 and PHY 222 (206).

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**MAE 310. Heat Transfer. 3 Credit Hours.**

Application of elementary methods of solution to heat transfer problems involving steady and unsteady state conduction, radiation, and convection. Introduction of meaningful experimental data is also included.

Prerequisite: MAE 303 And MTH 311.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 341. Mechanical Design I. 3 Credit Hours.**

Concepts and software for kinematics, solid modeling, and project management. Fundamentals of mechanical design: stresses in and failure of mechanical elements. Individual and group design projects.

Prerequisite: MAE 202 and MAE 207.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 342. Mechanical Design II. 3 Credit Hours.**

Review of the design process and creativity in design. Topics include design and reliability of gears, shafts, etc. Individual and group design projects are included.

Prerequisite: MAE 341.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 351. Mechanics Laboratory. 2 Credit Hours.**

Exercises in the experimental determination of the mechanical properties of materials and the static and dynamic characteristics of mechanical and structural elements. Lecture, 1 hour; laboratory, 3 hours.

Prerequisite: MAE 302.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 362. Computer Analysis of Mechanical and Aerospace Engineering Problems. 3 Credit Hours.**

Exploration of physical systems behavior using discrete models. Topics include numerical analysis, solid modeling, and software evaluation. Students solve engineering problems using student-developed and existing software.

Prerequisite: MAE 341 and MTH 211. Corequisite: MAE 310.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 371. Aerodynamics. 3 Credit Hours.**

Course discusses the history of flight. Topics include fundamental variables, the atmosphere, basic equations, their approximations, compressibility, viscosity, flow regimes potential flow, and aerodynamics of airfoil and wing.

Prerequisite: MAE 309.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 399. Cooperative Education. 1 Credit Hour.**

Practical application of classroom theory through alternating semester or summer employment with firms offering positions consistent with the student's field of study. Course may be repeated.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**MAE 404. Experimental Engineering Laboratory. 2 Credit Hours.**

Experimental analysis of problems in fluid mechanics, thermodynamics, and other areas of engineering. Lecture, 1 hour; laboratory, 3 hours.

Prerequisite: MAE 303 and MAE 309 and MAE 310.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**MAE 408. Heating, Ventilating, and Air Conditioning. 3 Credit Hours.**

Principles and procedures for the analysis and design of heating, ventilating and air conditioning (HVAC) systems, including moist air properties and conditioning processes, heating and cooling load calculations, building energy consumption, thermal comfort, and indoor air quality. Not available for students having taken MAE 405.

Prerequisite: MAE 303.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 412. System Dynamics. 3 Credit Hours.**

Course topics include dynamic modeling of mechanical and thermo-fluid systems. Laplace transforms, transfer functions, energy concepts, causality, linearity, linear graph models, energy transducing system elements, frequency domain methods.

Prerequisite: ECE 201 or ECE 205 and MAE 202 and MAE 309.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 415. Automatic Control. 3 Credit Hours.**

Introduction to system theory, transfer functions, and state space modeling of physical systems. Course topics include stability, analysis and design of PID, Lead/Lag, other forms of controllers in time and frequency domains, root locus Bode diagrams, gain and phase margins, Nichols chart, Nyquist criterion, and systems with time delay.

Senior Standing.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 420. Applied Thermodynamics. 3 Credit Hours.**

Cycle irreversibility; energy. Power and refrigeration cycles. Behavior of mixtures and solutions. Chemical thermodynamics, including combustion fundamentals. Compressible fluids. Advanced energy systems.

Prerequisite: MAE 303.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 440. Introduction to Capstone Design. 3 Credit Hours.**

Lectures and classroom discussion of the design process including product safety and manufacturability. Students are required to initiate the process of designing, fabricating, testing and analyzing the data from a design project chosen by the students. The students are required to form groups to accomplish the desired objectives of the design project.

Prerequisite: MAE 303 and MAE 309.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 441. Design of Fluid and Thermal Systems. 3 Credit Hours.**

Course topics include thermal and fluid systems design fundamentals, piping systems, selection of pumps, piping system design practices, classification of heat exchangers. Basic design methods of heat exchange equipment is also included.

Prerequisite: MAE 309 and MAE 310.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 442. Capstone Design Project-I. 1 Credit Hour.**

Lectures and classroom discussions cover (i) legal, ethical, and societal responsibilities of engineers, (ii) design factors such as product safety, reliability, life cycle costs, and manufacturability, and (iii) other aspects such as global market, contemporary issues, and continuous learning process. Students are required to select group design projects from the breadth of mechanical engineering activity and present project to serve as the basis for MAE 443.

Prerequisite: MAE 440 or Permission of Instructor.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 443. Capstone Design Project-II. 2 Credit Hours.**

Continuation of the Capstone Design Project-I course. A mechanical system is designed, implemented, documented, and presented.

Prerequisite: MAE 442 or Permission of Instructor.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 444. Capstone Aerospace Design Project-I. 3 Credit Hours.**

Lectures and classroom discussions cover (i) legal, ethical and societal responsibilities of engineers, (ii) design factors such as product safety, reliability, life cycle costs and manufacturability, and (iii) other aspects such as global market, contemporary issues and continuous learning process. Students are required to select group design projects from the breadth of aerospace engineering activity and present project proposals to serve as the basis for MAE 445.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 445. Capstone Aerospace Design Project-II. 3 Credit Hours.**

Continuation of the Capstone Aerospace Design Project-I course. An aerospace system/subsystem is designed, implemented, documented and presented.

Prerequisite: MAE 444 or Permission of Instructor.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 446. Aircraft Design. 3 Credit Hours.**

Concepts of aircraft design emphasizing on design layout including the airfoil geometry selection, propulsion integration, configuration layout, payload and landing gear system. Corequisite: MAE 471.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 470. Introduction to Aerospace Structures. 3 Credit Hours.**

Course topics include mechanics of thin-walled aerospace structures, load analysis, virtual work, energy principles, stability of aerostructures, and finite element methods.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 471. Flight Dynamics. 3 Credit Hours.**

Course topics include aerodynamic performance, stability, control, propulsion systems, and structures. Case Studies of Aerospace Systems are also included.

Prerequisite: MAE 371.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 472. Design of Aerospace Structures. 3 Credit Hours.**

Design Philosophy and principles of aerospace structures. Detailed design of wing box structure, fuselage, landing gear mechanism, fasteners and structural joints. Application of composite materials.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 473. Aerospace Propulsion. 3 Credit Hours.**

Definition of the atmosphere, propulsion basics, rocket fundamentals, turbine fundamentals, gas turbine cycles, component matching, math and computer models, aircraft missions, cycle section, reliability, and durability are analyzed.

Prerequisite/co-requisite: MAE 303 And MAE 371.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 490. Undergraduate Research. 1-3 Credit Hours.**

Research Projects. Individual investigation of current problems.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**MAE 501. Methods of Engineering Analysis. 3 Credit Hours.**

Analysis of engineering systems in equilibrium and motion. Examples considered from mechanical, electrical, thermal and fluids engineering. Mathematical theory and computer methods for obtaining numerical solutions are developed for various cases involving discrete and continuous systems. Lecture, 3 hours.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 502. Vibrations. 3 Credit Hours.**

Basic theory of free and forced vibrations of mechanical systems with and without damping. Applications to systems with one and several degrees of freedom are included.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 503. Internal Combustion Engines. 3 Credit Hours.**

Course discusses engine types, characteristics, and operation. Topics include performance factors, fuel combustion, power cycles, knock and engine variables, exhaust emissions, fuel metering, compressors, and turbines.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 504. Orbitals Mechanics. 3 Credit Hours.**

Analysis of orbits in an inverse-square gravitational field; elementary rocket dynamics, impulsive orbit transfer and rendezvous, and Lambert's Theorem with applications; patched-conic trajectories, planetary gravity-assist maneuvers, and linearized orbit theory with application to simplified analytical models; perturbations

Prerequisite: MAE 202.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 505. Design for Manufacturability. 3 Credit Hours.**

Manufacturing concerns at design stage. Design theory and methodology. Statistical considerations in geometric dimensioning, tolerances, reliability-based design, and quality control. Producibility, design for assembly, and value engineering. Life cycle costs and optimum design using nonlinear programming and Taguchi approaches. Hands on projects on machine tools.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 506. Nuclear Engineering. 3 Credit Hours.**

Course topics include a review of neutron physics, chain reactions, reactor theory, steady state operation, and reactor kinetics. Control, long term reactivity changes, materials, heat transfer, and shielding are also included. Lecture, 3 hours.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 507. Advanced Mechanics of Solids. 3 Credit Hours.**

Courses discusses the basic elements of elasticity, plasticity, and viscoelasticity. Application to mechanical systems at rest and in motion are included.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 508. Intermediate Heat Transfer. 3 Credit Hours.**

Course discusses steady and unsteady heat transfer by conduction, convective heat transfer in laminar and turbulent fluid flow, natural convection, and heat transfer by radiation.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 509. Turbomachinery Aero-thermodynamics. 3 Credit Hours.**

Basic concepts of turbo machinery principle and thermo aerodynamic design , including gas-turbine engine cycles, compressor and turbine cascade, energy transfer in turbomachines, velocity diagrams, design and prediction of axial-flow compressors and turbines, radial-flow turbomachines, etc  
Prerequisite: MAE 371 And MAE 303.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 510. Fundamentals of Solar Energy Utilization. 3 Credit Hours.**

Fundamentals basic to the design and performance analysis of thermal systems for the capture and utilization of Solar Energy.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 512. Intermediate Fluid Mechanics. 3 Credit Hours.**

Course topics include conservation of mass, momentum, and energy, potential flow, viscous laminar and turbulent flows, the Reynolds analogy, and Boundary-layer approximations. Gas dynamics are also discussed.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 514. Advanced Internal Combustion Engines Experimental Studies. 3 Credit Hours.**

Experimental mechanical engineering as it pertains to internal combustion engines. The principal measurements necessary to analyze the operation of an internal combustion engine are covered. Emphasis is placed on experiment planning, data interpretation, and error analysis.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 516. Introduction to Composite Materials. 3 Credit Hours.**

Course provides an introduction to composite materials and terminology. Topics include advantages offered by composite materials, current aerospace, automotive, and bio-mechanics applications, experimental results, analytical models, and effects of impact and fatigue loads. The environment's impact on composite materials' performance and design procedures are discussed. Case studies examining composite materials as efficient replacements are also included.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 521. Exhaust Emission Control. 3 Credit Hours.**

Course topics include automotive emissions, air pollution, combustion of homogeneous mixtures, emission control systems, Federal emission standards, and emission instrumentation and measurement. Lecture, 2 hours; Laboratory, 3 hours.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 528. Fuel Cells. 3 Credit Hours.**

Introduction to fuel cells, thermodynamics of fuel cells, electrochemical kinetics in fuel cells, transport phenomena in fuel cells, introduction to various types of fuel cells.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 531. Scientific and Engineering Foundations of Additive Manufacturing. 3 Credit Hours.**

This course introduces the AM technologies and covers the core materials science and manufacturing engineering fundamentals upon which the technologies are built. Advantages and limitations of the AM technologies are highlighted, along with future opportunities.

Prerequisite: MAE 301.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 532. Additive Manufacturing of Engineering Materials. 3 Credit Hours.**

This course focuses on teaching the processing, structure, and property relationships in metals, polymers, polymer-based composites, and bio-compatible materials fabricated using additive manufacturing (AM). Students will be exposed to conventional and advanced applications of AM technologies.

Prerequisite: MAE 301.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 539. Heating, Ventilating and Air Conditioning System Design. 3 Credit Hours.**

Course topics include basic HVAC systems, multizone systems, dual-duct systems, terminal reheat systems, variable air volume systems, induction and induction reheat systems, special applications, hydronic systems, unitary and heat pump systems, hydronic heat recovery systems, cooling and heating load calculation duct and piping design, overall system design, and integration.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 540. Energy Conversion. 3 Credit Hours.**

Course topics include energy conversion, utilization, present and projected consumption of energy, thermodynamic principles, nuclear energy, fission and fusion reactions, hydroelectric power, and solar energy. Alternative energy sources, the hydrogen economy, and the energy-environment-economy system are also discussed.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 551. Special Problems. 1-3 Credit Hours.**

Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**MAE 552. Special Problems. 1-3 Credit Hours.**

Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**MAE 590. Special Topics. 1-4 Credit Hours.**

Subtitles describing the topics will be shown in parentheses in the class schedule, following the "Special Topics."

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 591. Special Topics. 1-4 Credit Hours.**

Subtitles describing the topics will be shown in parentheses in the class schedule, following the "Special Topics."

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 592. Special Topics. 1-4 Credit Hours.**

Subtitles describing the topics will be shown in parentheses in the class schedule, following the "Special Topics."

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 599. Cooperative Education. 1 Credit Hour.**

Practical application of classroom theory through alternating semester or summer employment with industries offering positions consistent with the student's field of study. Course may be repeated. Periodic reports and conferences are required.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**MAE 601. Methods of Engineering Analysis. 3 Credit Hours.**

Analysis of engineering systems in equilibrium and motion. Examples considered from mechanical, electrical, thermal and fluids engineering. Mathematical theory and computer methods for obtaining numerical solutions are developed for various cases involving discrete and continuous systems. Lecture, 3 hours.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 602. Vibrations. 3 Credit Hours.**

Basic theory of free and forced vibrations of mechanical systems with and without damping. Applications to systems with one and several degrees of freedom are included.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 603. Internal Combustion Engines. 3 Credit Hours.**

Course discusses engine types, characteristics, and operation. Topics include performance factors, fuel combustion, power cycles, knock and engine variables, exhaust emissions, fuel metering, compressors, and turbines.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 604. Orbital Mechanics. 3 Credit Hours.**

: Analysis of orbits in an inverse-square gravitational field; elementary rocket dynamics, impulsive orbit transfer and rendezvous, and Lambert's Theorem with applications; patched-conic trajectories, planetary gravity-assist maneuvers, and linearized orbit theory with application to simplified analytical models; perturbations. Prerequisite: MAE 202, or consent of instructor. 3 undergraduate hours or 3 graduate hours.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 605. Design for Manufacturability. 3 Credit Hours.**

Manufacturing concerns at design stage. Design theory and methodology. Statistical considerations in geometric dimensioning, tolerances, reliability-based design, and quality control. Producibility, design for assembly, and value engineering. Life cycle costs and optimum design using nonlinear programming and Taguchi approaches. Hands on projects on machine tools.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 607. Advanced Mechanics of Solids. 3 Credit Hours.**

Course discusses the basic elements of elasticity, plasticity, and viscoelasticity. Application to mechanical systems at rest and in motion are included.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 608. Intermediate Heat Transfer. 3 Credit Hours.**

Course discusses steady and unsteady heat transfer by conduction, convective heat transfer in laminar and turbulent fluid flow, natural convection, and heat transfer by radiation.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 609. Turbomachinery Aero-thermodynamics. 3 Credit Hours.**

Basic concepts of turbo machinery principle and thermoaerodynamic design, including gas-turbine engine cycles, compressor and turbine cascade, energy transfer in turbomachines, velocity diagrams, design and prediction of axial-flow compressors and turbines, radial-flow turbomachines, etc. Prerequisite: MAE 371 And MAE 303.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 612. Intermediate Fluid Mechanics. 3 Credit Hours.**

Course topics include conservation of mass, momentum, and energy, potential flow, viscous laminar and turbulent flows, the Reynolds analogy, and Boundary-layer approximations. Gas dynamics are also discussed.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.



**MAE 614. Advanced Internal Combustion Engines Experimental Studies. 3 Credit Hours.**

Experimental mechanical engineering as it pertains to internal combustion engines. The principal measurements necessary to analyze the operation of an internal combustion engine are covered. Emphasis is placed on experiment planning, data interpretation, and error analysis.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 616. Introduction to Composite Materials. 3 Credit Hours.**

Course provides an introduction to composite materials and terminology. Topics include advantages offered by composite materials, current aerospace, automotive, and bio-mechanics applications, experimental results, analytical models, and effects of impact and fatigue loads. The environment's impact on composite materials' performance and design procedures are discussed. Case studies examining composite materials as efficient replacements are also included.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 621. Exhaust Emission Control. 3 Credit Hours.**

Course topics include automotive emissions, air pollution, combustion of homogeneous mixtures, emission control systems, Federal emission standards, and emission instrumentation and measurement. Lecture, 2 hours; Laboratory, 3 hours.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 628. Fuel Cells. 3 Credit Hours.**

Introduction to fuel cells, thermodynamics of fuel cells, electrochemical kinetics in fuel cells, transport phenomena in fuel cells, introduction to various types of fuel cells.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 631. Scientific and Engineering Foundations of Additive Manufacturing. 3 Credit Hours.**

This course introduces the AM technologies and covers the core materials science and manufacturing engineering fundamentals upon which the technologies are built. Advantages and limitations of the AM technologies are highlighted, along with future opportunities.

Prerequisite: MAE 301.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 632. Additive Manufacturing of Engineering Materials. 3 Credit Hours.**

This course focuses on teaching the processing, structure, and property relationships in metals, polymers, polymer-based composites, and bio-compatible materials fabricated using additive manufacturing (AM). Students will be exposed to conventional and advanced applications of AM technologies.

Prerequisite: MAE 301.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 639. Heating, Ventilating and Air Conditioning System Design. 3 Credit Hours.**

Course topics include basic HVAC systems, multizone systems, dual-duct systems, terminal reheat systems, variable air volume systems, induction and induction reheat systems, special applications, hydronic systems, unitary and heat pump systems, hydronic heat recovery systems, cooling and heating load calculation duct and piping design, overall system design, and integration.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 640. Energy Conversion. 3 Credit Hours.**

Course topics include energy conversion, utilization, present and projected consumption of energy, thermodynamic principles, nuclear energy, fission and fusion reactions, hydroelectric power, and solar energy. Alternative energy sources, the hydrogen economy, and the energy-environment-economy system are also discussed.

Senior Standing.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 651. Special Problems. 1-3 Credit Hours.**

Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**MAE 652. Special Problems. 1-3 Credit Hours.**

Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**MAE 690. Special Topics. 1-4 Credit Hours.**

Subtitles describing the topics will be shown in parentheses in the class schedule, following the "Special Topics."

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 691. Special Topics. 1-4 Credit Hours.**

Subtitles describing the topics will be shown in parentheses in the class schedule, following the "Special Topics."

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 692. Special Topics. 1-4 Credit Hours.**

Subtitles describing the topics will be shown in parentheses in the class schedule, following the "Special Topics."

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 699. Cooperative Education. 1 Credit Hour.**

Practical application of classroom theory through alternating semester or summer employment with industries offering positions consistent with the student's field of study. Course may be repeated. Periodic reports and conferences are required.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**MAE 701. Advanced Heat Transfer--Conduction and Radiation. 3 Credit Hours.**

Advanced analytical methods of solutions of boundary value problems of steady, periodic, and unsteady heat conductions. Topics include techniques of transient point, line, and plane sources and sinks, thermodynamics of radiative equilibrium, radiative exchange, geometrical factors, network, and other methods. Lecture, 3 hours.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 702. Advanced Heat Transfer--Convection. 3 Credit Hours.**

The analogy between heat, mass, and momentum transfers. Topics include the transfer mechanism, heat transfer to liquid metals, boiling and condensation mechanisms, heat transfer in two-phase flow, ablation heat transfer, transpiration, film cooling, and heat exchanges. Lecture, 3 hours.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 703. Graduate Research Seminar. 1 Credit Hour.**

Attendance and active participation in a designated semester seminar series.

**Components:** LEC.

**Grading:** SUS.

**Typically Offered:** Fall & Spring.

**MAE 704. Graduate Teaching. 1-3 Credit Hours.**

Teaching or assisting in a course with a substantial level of instructional responsibility. Only open to doctoral students.

**Components:** LEC.

**Grading:** SUS.

**Typically Offered:** Fall & Spring.

**MAE 705. Finite Element Methods in Mechanical and Aerospace Engineering. 3 Credit Hours.**

Finite-element analysis methods for static and dynamic analysis of mechanical and aerospace structures, heat transfer analysis, and fluid flow applications. Primary emphasis is placed on underlying mechanics and numerical techniques. Consideration is also given to the use of existing programs, such as ANSYS, NASTRAN and FIDAP, designing proper meshes, and choosing the proper element. A term project is included.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 706. Experimental Methods in Fluid Mechanics. 3 Credit Hours.**

Course topics include methods of flow visualization, laser techniques in measurement of wall motions, conduit compliance, Newtonian and non-Newtonian properties of fluids, measurement of unsteady flow and pressure, laser Doppler anemometry, ultrasound Doppler velocimetry, electromagnetic flowmetry, measurement of steady and unsteady wall shear stresses and boundary layers.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 713. Transport Phenomena. 3 Credit Hours.**

Course topics include laws of molecular transfer, the kinetic theory explanation of molecular transfer phenomena, introduction to turbulence, and molecular transfer in laminar and turbulent flows with experimental results. A unified treatment of salient aspects of momentum, heat, and mass transfer including the relationship between rate and conservation equations are also discussed.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 714. Computational Fluid Dynamics. 3 Credit Hours.**

Incompressible flow equations in rectangular co-ordinates. Topics include basic computational methods for incompressible flow, three dimensional flows, compressible flow equations in rectangular coordinates, basic computational methods for compressible flows, treatment of shocks, artificial viscosities, convergence, other mesh systems, programming, testing, and information processing.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 730. Mechanical Systems Optimization. 3 Credit Hours.**

Optimization as an element of the engineering design process. Topics include comparative examination of unconstrained algorithms, as well as development and application of methods for constrained optimization problems. Case studies which demonstrate the theory and application of mathematical programming as a design tool are also included.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**MAE 733. Additive Manufacturing Lab. 3 Credit Hours.**

This course covers the hands-on experiments for the recent additive manufacturing technologies

Prerequisite: MAE 301.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 740. Continuum Mechanics. 3 Credit Hours.**

Course discusses concepts that are common to all continuous media. Topics include elements of tensor analysis, motion, deformation, vorticity, material derivatives, mass balance equation, and balance of linear and angular momentum as well as energy. Stress and its geometric characterization, constitutive equations of solid and fluid type behavior, fundamental applications, and the Clausius-Duhem inequality are also covered.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**MAE 751. Master's Project. 3 Credit Hours.**

A required project for M.S. students in the non-thesis option.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**MAE 752. Master's Capstone Project. 4 Credit Hours.**

A required project for the five year BSME/MSME program.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**MAE 762. CAD and FEM for Stress Analysis of 3D Printed Structures. 3 Credit Hours.**

Computer aided design and analyses of physical systems behavior using discrete models. Topics include CAD design, numerical analysis, and FEM modeling of 3D printed materials and structures. Students solve engineering problems using student-developed and existing software.

Prerequisite: MAE 362 Or Graduate student standing.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 780. Graduate Colloquium. 1 Credit Hour.**

Presentations by selected speakers of weekly programs dealing with topics of interest in Mechanical Engineering. Attendance is required of all students registered in Mechanical Engineering graduate programs.

**Components:** SEM.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**MAE 791. Professional Communications Skills for Engineering Grad Students. 0 Credit Hours.**

This course covers fundamental areas in professional communication for Engineering graduate students. Topic areas include: presenting research at conferences, writing manuscripts for publication, preparing the dissertation, the PhD comprehensive exams, effective teaching and mentoring, and obtaining positions in academia. Through interactive workshops, in-class exercises, brief presentations and assignments, students will have an opportunity to practice and strengthen necessary communication skills, developing collaborations, and developing effective presentation skills.

**Components:** LEC.

**Grading:** SUS.

**Typically Offered:** Offered by Announcement Only.

**MAE 792. Special Problems. 1-3 Credit Hours.**

Research and/or design projects consisting of individual investigation of current problems. Offered by special arrangement only.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**MAE 798. Advanced Topics. 1-3 Credit Hours.**

Subject matter offerings based upon student demand and availability of faculty. Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**MAE 810. Master's Thesis. 1-6 Credit Hours.**

The student working on his/her master's thesis enrolls for credit, in most departments not to exceed six, as determined by his/her advisor. Credit is not awarded until the thesis has been accepted.

**Components:** THI.

**Grading:** SUS.

**Typically Offered:** Fall, Spring, & Summer.

**MAE 820. Research in Residence. 1 Credit Hour.**

Used to establish research in residence for the thesis for the master's degree after the student has enrolled for the permissible cumulative total in MAE 710 (usually six credits). Credit not granted. May be regarded as full time residence.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**MAE 830. Pre-Candidacy Doctoral Dissertation. 1-12 Credit Hours.**

Doctoral dissertation credits taken prior to Ph.D. student's candidacy. The student will enroll for credit as determined by his/her advisor. Not more than 12 hours of MAE 730 may be taken in a regular semester, nor more than six in a summer session.

**Components:** THI.

**Grading:** SUS.

**Typically Offered:** Fall, Spring, & Summer.

**MAE 840. Post-Candidacy Doctoral Dissertation. 1-12 Credit Hours.**

Doctoral dissertation credits taken after Ph.D. student has been admitted to candidacy. The student will enroll for credit as determined by his/her advisor. Not more than 12 credits in MAE 740 may be taken in a regular semester, nor more than six credits in a summer session.

**Components:** THI.

**Grading:** SUS.

**Typically Offered:** Fall, Spring, & Summer.

**MAE 850. Research in Residence. 1 Credit Hour.**

Used to establish research in residence for the Ph.D. and D.A., after the student has been enrolled for the permissible cumulative total in appropriate doctoral research. Credit not granted. May be regarded as full-time residence as determined by the Dean of the Graduate School.

**Components:** THI.

**Grading:** SUS.

**Typically Offered:** Fall, Spring, & Summer.