

MECHANICAL AND AEROSPACE ENGINEERING

<https://mae.coe.miami.edu/index.html>

Dept. Code: MAE

Degree Programs

The Department of Mechanical and Aerospace Engineering offers courses and provides facilities for two programs of graduate study and research in Mechanical Engineering, leading to the degrees of:

1. Master of Science (p. 2)
2. Doctor of Philosophy (<http://bulletin.miami.edu/graduate-academic-programs/engineering/mechanical-aerospace-engineering/mechanical-engineering-phd/>)

The program of study must reflect the importance of underlying principles of the physical sciences and mathematical analysis to all phases of modern mechanical engineering.

Areas of Research

- Fluid Mechanics
- Biomechanics
- Solid Mechanics
- Composite Materials
- Optimization and Reliability
- Nano Mechanics
- Heat Transfer
- Hydrogen Energy
- Materials Science
- Internal Combustion Engines
- Controls and Design
- Aerodynamics and CFD
- Nano-Bio-Systems
- Fuel Cells

It is expected that each graduate student will indicate early in his/her graduate work (within the first year), the particular area in which he/she intends to concentrate his/her efforts as well as the faculty advisor for dissertation.

500 level courses are open to advanced undergraduates and to graduate students; 600 level courses are open only to graduate students.

Clean Energy Research Institute

1. The Clean Energy Research Institute in the Department of Mechanical and Aerospace Engineering acts as the focal point of energy and environment related activities in the College of Engineering.
2. Its goals are:
 - to conduct research and to generate research proposals to investigate energy and environmental problems;
 - to organize seminars, workshops and conferences using researchers within and without the University;
 - to assemble, compile, publish and disseminate information on every aspect of energy and environmental problems; and
 - to cooperate with other organs of the University, other academic institutions, government and private organizations in connection with the above listed activities.
3. The current activities of the Institute include research into hydrogen as a clean, inexhaustible synthetic fuel, environmental damage caused by fossil fuels, global warming and its remediation, instabilities in boiling systems, solar cooling and heating, hybrid solar collectors, remote sensing applied to energy related problems and solar energy, system optimization and reliability of solar and wind energy systems, and organization of national and international conferences and symposia on energy and environmental problems.

Research Laboratories

- Advanced Nano Systems Laboratory
- Aerospace Materials Simulation Laboratory
- Aerosol and Air Sensing Group

- Computational Fluid Dynamics Laboratory
- Fuel Cells Laboratory
- Internal Combustion Laboratory
- Materials Laboratory
- Micromechanics Laboratory
- Measurements Laboratory
- Robotics and Intelligent Systems Engineering Laboratory
- Thermo-Fluid Mechanics Laboratory
- Tissue Biomechanics Laboratory
- Wind Tunnel Laboratory

Masters Programs in Mechanical and Aerospace Engineering

1. M.S. in Mechanical Engineering (<https://bulletin.miami.edu/graduate-academic-programs/engineering/mechanical-aerospace-engineering/mechanical-engineering-ms/>)
 - a. non-thesis option
 - b. thesis option
2. M.S. in Sports Engineering (<https://bulletin.miami.edu/graduate-academic-programs/engineering/mechanical-aerospace-engineering/sports-engineering-ms/>)
 - a. non-thesis option
 - b. thesis option

Doctoral Program in Mechanical and Aerospace Engineering

- Ph.D. in Mechanical Engineering (<https://bulletin.miami.edu/graduate-academic-programs/engineering/mechanical-aerospace-engineering/mechanical-engineering-phd/>)

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: Spring.

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.

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 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

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.

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.

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.

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 687. Fundamentals of Microfabrication. 3 Credit Hours.

MEMS technology and applications have grown at a tremendous pace, while structural dimensions have grown smaller and smaller, reaching down even to the molecular level. With this movement have come new types of applications and rapid advances in the technologies and techniques needed to fabricate the increasingly miniature devices that are literally changing our world. This course describes the science of miniaturization and brings an understanding of manufacturing options, material choices, and applications that have emerged recently.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

MAE 688. Traffic Accident Reconstruction I. 3 Credit Hours.

The course will provide necessary skills to reconstruct a traffic crash from on-scene evidence and properly document the findings. Specifically, measurement techniques and photographing will be discussed; scale diagramming will be shown and practiced. An introduction to methods for accident reconstruction will be provided to analyze the collected information and determine what happened before, during and after the collision.

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

MAE 689. Traffic Accident Reconstruction II. 3 Credit Hours.

The course will provide analytical skills to conduct a traffic crash analysis and properly document the findings. Specifically, derivation and origin of the commonly used mathematical formulas used for reconstruction will be discussed. Vehicle speed at impact, in-line and eccentric collisions, direction of travel, initial contact and position of vehicles on the roadway, and delta V will be analyzed. Critical speed calculations, lane changes and turn-away equation and airborne analysis will be presented. Introductions to measurement techniques and photographing will be discussed; scale diagramming will be shown and practiced. An introduction to commercial vehicle and motorcycle dynamics in collision will be provided.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

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: Offered by Announcement Only.

MAE 733. Additive Manufacturing Lab. 3 Credit Hours.

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

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 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.

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.