

Mechanical and Aerospace Engineering

Noah D. Manring, Chair and Glen A. Barton Professor
College of Engineering
E2412 Laffer Hall
(573) 882-0693
ManringN@missouri.edu

The Department of Mechanical and Aerospace Engineering is an academic department within the College of Engineering at the University of Missouri.

Established in 1891, this ABET accredited program is home to many undergraduate and graduate students and faculty.

Faculty

See web site for faculty listing: <https://engineering.missouri.edu/departments/mechanical-aerospace-engineering/mae-faculty/>

- * Graduate Faculty Member - membership is required to teach graduate-level courses, chair master's thesis committees, and serve on doctoral examination and dissertation committees.
- ** Doctoral Faculty Member - membership is required to chair doctoral examination or dissertation committees. Graduate faculty membership is a prerequisite for Doctoral faculty membership.

Undergraduate

- BSME in Mechanical Engineering (<http://catalog.missouri.edu/undergraduategraduate/collegeofengineering/mechanicalandaerospaceengineering/bsme-mechanical-aerospace-engineering>)
 - with emphasis in Aerospace Engineering (<http://catalog.missouri.edu/undergraduategraduate/collegeofengineering/mechanicalandaerospaceengineering/bsme-mechanical-engineering-aerospace>)

Additional minors and certificates (<http://catalog.missouri.edu/undergraduategraduate/collegeofengineering/additionalminorsandcertificates>) are offered through the College of Engineering, including the Aerospace Engineering Minor and the Energy Engineering Minor.

Advising Contact

Justin Rich
573-884-6961
RichJ@missouri.edu

Scholarship Contact

Craig Kluever, Undergraduate Director
KlueverC@missouri.edu

The Department of Mechanical and Aerospace Engineering prepares students for productive careers in mechanical engineering related disciplines. The program focuses on instruction in the thermal and mechanical systems areas as defined by the Accreditation Board for Engineering and Technology (ABET). To support that mission, the Department has been divided into the focus areas of Design and Manufacturing, Dynamics and Control, Materials, and Thermal-Fluid Sciences. (NOTE: Focus areas are not listed on transcripts or diplomas.)

The department endeavors to present an experimental program through laboratory experiences. Students take three lab courses that focus on instrumentation and measurements, materials and manufacturing, and thermal-fluid systems.

The MU Mechanical Engineering program offers a Bachelor of Science in Mechanical Engineering (BSME) and prepares students for practice of the profession in industry or government or for further study toward other degrees such as the JD, MD, MS, and PhD.

Mission Statement

The mission of the Mechanical and Aerospace Engineering Department is to:

Prepare our students for successful careers in the mechanical engineering profession, conduct high-quality and innovative research, and serve the community and industry providing educational and research resources.

Program Educational Objectives

The educational objectives of the undergraduate program in Mechanical Engineering are to produce graduates who (within a few years of graduation):

1. successfully practice the mechanical engineering disciplines;
2. contribute to society and the engineering profession;
3. engage in life-long learning to advance professionally through continuing education and training;
4. succeed in graduate studies in mechanical engineering or a related field if pursued.

ABET Definition for Program Educational Objectives: Program Education Objectives are broad statements that describe what graduates are expected to attain within a few years of graduation. Program Educational Objectives are based on the needs of the program's constituencies.

Program Outcomes

Students from the Mechanical Engineering program will attain (by the time of graduation):

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Double Majors and Dual Degrees

Dual majors and dual degrees are possible at the undergraduate level. These could lead to degrees in the College of Engineering and the College of Arts and Sciences or the College of Agriculture. Dual enrollments could also lead to two engineering majors within the College of Engineering. Any of these dual enrollments would add to the traditional 126-credit undergraduate degree program. Consult with the directors of undergraduate studies of the departments involved for further information.

MAE Honors Program

The MAE Honors Program follows the general rules, regulations and philosophy of the College of Engineering Honors Program, and as such is intended to encourage, facilitate and reward independent study by high-ability undergraduate students.

The heart of the program is an undergraduate honors project, undertaken and completed by the time of graduation while enrolling in 1 to 6 credits of MAE 4995 Undergraduate Honors Research Mechanical & Aerospace Engineering. The academic credit for the honors project (1-6 credits in MAE 4995 replaces an equivalent number of credits of technical or MAE elective. The project is conducted under the direction of an MAE professor (honors advisor) who is selected by the student, with agreement by the professor. The project culminates in an honors thesis, which is read and approved by the honors advisor and then approved by the chair of the MAE honors committee. A finished copy of the honors thesis, signed by the honors advisor and second reader, is required for satisfactory completion of the project.

Academic Qualifications for the Honors Program

In the case of a transfer student, transferred credit plus MU credit must average 3.0/4.0. A student is typically eligible for the honors program at the junior year of their undergraduate program.

The successful honors scholar is given a degree of flexibility in the program of study. Additionally, honors scholars may reduce the credits required for degree completion to the University minimum (i.e., 120 credits) by substituting graduate course credits through dual enrollment (undergraduate/graduate at MU) during the last two semesters of the undergraduate program.

Honors students must maintain and graduate with a 3.0 overall GPA.

In the case of a transfer student, transferred credit plus MU credit must average 3.0/4.0. A student is typically eligible for the honors program at the junior year of their undergraduate program.

The successful honors scholar is given a degree of flexibility in the program of study. Additionally, honors scholars may reduce the credits required for degree completion to the University minimum (i.e., 120 credits) by substituting graduate course credits through dual enrollment (undergraduate/graduate at MU) during the last two semesters of the undergraduate program.

Graduate

- MS in Mechanical and Aerospace Engineering (<http://catalog.missouri.edu/undergraduategraduate/collegeofengineering/mechanicalandaerospaceengineering/ms-mechanical-aerospace-engineering>)

- PhD in Mechanical and Aerospace Engineering (<http://catalog.missouri.edu/undergraduategraduate/collegeofengineering/mechanicalandaerospaceengineering/phd-mechanical-aerospace-engineering>)

College of Engineering

E2413 Lafferre Hall

<https://engineering.missouri.edu/departments/mechanical-aerospace-engineering/>

Director of Graduate Studies: Frank Feng

About Mechanical & Aerospace Engineering

Like markets merging together to create a global economy, this decade has approached the exciting frontier of joint research. The marriage of Mechanical Engineering to related fields has contributed to a new "Interdisciplinary Era". In meeting the challenges brought on by this co-operative approach to engineering, the Department of Mechanical & Aerospace Engineering (MAE) at the University of Missouri has broadened its scope in both education and research while maintaining strengths in the fundamental disciplines: Dynamics & Control, Design & Manufacturing, Materials & Solids and Thermal & Fluid Science Engineering. Such well-established academic traditions in the undergraduate and graduate curriculum as well as nationally renowned research programs are the basis for MAE having become the largest department in the College of Engineering at MU. An equally important aspect contributing to the quality of the MAE department is the aggressive pursuit of funding, by our faculty, to establish nationally recognized research programs. Well-earned support through sizable funding from both federal agencies and industry are valuable resources in the promotion of our graduate research and undergraduate teaching.

Career Opportunities

Graduate programs are planned to prepare students for advanced professional engineering careers. In recognition of the broad nature of the field of mechanical and aerospace engineering, considerable latitude in programs is encouraged so students may prepare for employment in industry, education and government. The usual purpose of a PhD program is to prepare a person for a career in research or teaching. The program is oriented toward research culminating in a dissertation suitable for publication.

Areas of Study

A student may pursue an area of concentration selected from AI/expert systems, automation, bioengineering, combustion, control, creep and plasticity, design optimization, numerical methods, computational fluid dynamics, fracture mechanics, heat transfer, interactive computer graphics, laser diagnostics, manufacturing systems, materials science, mechanical syntheses, mechatronics, mechanics, parallel computation, residual stress, robotics, thermal systems design and management and ultrasonic nondestructive evaluation.

Licensure

Information on degree requirements for engineering licensure is detailed under Professional Engineering Registration.

Facilities and Equipment

The department has several specialized laboratories in aerosol mechanics, combustion, computer control, creep and fracture mechanics, fluid mechanics and heat transfer, manufacturing, materials science and structural dynamics.

Besides the modern instrumentation and equipment normally found in well-equipped mechanical and aerospace engineering laboratories, the department has, or has access to, such specialty items as MTS and Instron material and structural test equipment, wind tunnels, X-ray and a scanning electron microscope facility, computer control systems, a scanning laser vibrometer, a microscale heat transfer and electronic coding laboratory, an experimental stress laboratory, a fluid power laboratory and the university research reactor.

Information Technology and Computing

A combination of the campus Division of Information Technology and the Engineering Technical Services (ETS) provided advanced engineering computation for College of Engineering faculty and students. CAD/CAM and graphics are the primary emphasis, although artificial intelligence, multiple high-level programming languages and computational and simulation libraries also are available.

The College of Engineering operates one high performance enterprise server, two super minicomputers and 17 HP workstations. The ETS also provides hardware/software support, locally, to nine College of Engineering departments and their affiliated research centers. These units are networked via Ethernet to the superminicomputers operated by the College of Engineering.

The Division of IT operates two remote terminal sites in the Engineering Buildings East. The University also supports an extensive computer system consisting of IBM mainframe computers, remote terminal sites, and PC and Macintosh labs throughout the campus.

Financial Aid from the Program

Admission decisions to the graduate program are made without considerations of a student's financial need. Once admitted, a student may be considered for fellowships, research assistantships (RAs) and teaching assistantships (TAs). Awarding of fellowships is initiated by the department. RAs are awarded by individual faculty members. A student may apply by contacting faculty members directly. Application forms for TAs are available in the department office. International students are not eligible for TAs in their first semester of study. For specific departmental requirements, please refer to the MAE Graduate Handbook. Please see the department website for information on how to contact the professors individually about research assistantships offered.

MAE 1000: Introduction to Mechanical Engineering

Introduction to the mechanical engineering profession, the Mechanical and Aerospace Engineering Department and curriculum, and the core disciplines of mechanical engineering. Introduction to engineering problem solving, ethics, and design.

Credit Hour: 1

Prerequisites: Restricted to engineering students only

MAE 1100: Introduction to Computer Aided Design

Introduction to 2D and 3D mechanical modeling techniques using computer-aided design (CAD) software. Topics include 3D part and assembly modeling, 2D part and assembly drawings, standards of

engineering drawings, and basic animation and simulation. Graded on A-F basis only. Prerequisites/

Credit Hours: 3

Prerequisites: Restricted to Engineering Students only, or by departmental consent

Corequisites: MATH 1500

MAE 2100: Programming and Software Tools

Introduction to the use of computers, programming, and software. Topics include MATLAB syntax and programming techniques, algorithm design, and programming with Excel spreadsheets.

Credit Hours: 3

Prerequisites: grade of C- or better in MATH 1700. Restricted to Mechanical Aerospace Engineering students only

MAE 2300: Thermodynamics

(same as ENGINR 2300). Fluid properties, work and heat, first law, second law, entropy, applications to vapor and ideal gas processes.

Credit Hours: 3

Prerequisites: grade of C- or better in PHYSICS 2750; restricted to MAE students only

MAE 2600: Dynamics

Basic fundamentals of particle and rigid body dynamics; energy and momentum methods.

Credit Hours: 3

Prerequisites: grade of C- or better in ENGINR 1200. Restricted to Mechanical and Aerospace Engineering students only

MAE 3100: Computational Methods for Engineering Design

Introduction to numerical methods for linear system analysis, curve-fitting, integration and differentiation, and optimization. The numerical methods are demonstrated through computer implementation and application to engineering design problems.

Credit Hours: 4

Prerequisites or Corequisites: MATH 4100 grade of C- or better

Prerequisites: Grade of C- or better in MAE 2100; Restricted to Mechanical and Aerospace Engineering students only

MAE 3200: Engineering Materials

The nature of the structure of engineering materials. The relationship of material structure to physical properties. Mechanical behavior of engineering materials.

Credit Hours: 3

Prerequisites: Grade of C- or better in ENGINR 2200 and CHEM 1320. Restricted to Mechanical and Aerospace Engineering students only

MAE 3200W: Engineering Materials - Writing Intensive

The nature of the structure of engineering materials. The relationship of material structure to physical properties. Mechanical behavior of engineering materials.

Credit Hours: 3

Prerequisites: Grade of C- or better in ENGINR 2200 and CHEM 1320. Restricted to Mechanical and Aerospace Engineering students only

MAE 3400: Fluid Mechanics

A basic course in fluid mechanics. Topics include: fluid properties, hydrostatics, conservation laws, infinitesimal and finite control volume analysis, Navier-Stokes equations, dimensional analysis, internal and external flows.

Credit Hours: 3

Prerequisites or Corequisites: MAE 2300 grade of C- or better

Prerequisites: Grade of C- or better in MAE 2600; Restricted to Mechanical and Aerospace Engineering students only

MAE 3600: Dynamic Systems and Control

Modeling and analysis of dynamic systems and introduction to feedback control. Topics include dynamic modeling and response of mechanical, electrical, fluid, and thermal systems; and feedback control systems analysis.

Credit Hours: 3

Prerequisites or Corequisites: ENGINR 2100 grade of C- or better

Prerequisites: Grade of C- or better in MAE 2600 and MAE 3100 and MATH 4100. Restricted to Mechanical and Aerospace Engineering students only

MAE 3600H: Dynamic Systems and Control - Honors

Modeling and analysis of dynamic systems and introduction to feedback control. Topics include dynamic modeling and response of mechanical, electrical, fluid, and thermal systems; and feedback control systems analysis.

Credit Hours: 3

Prerequisites or Corequisites: ENGINR 2100 grade of C- or better

Prerequisites: Grade of C- or better in MAE 2600 and MAE 3100 and MATH 4100. Restricted to Mechanical and Aerospace Engineering students only. Honors eligibility required

MAE 3800: Instrumentation and Measurements Laboratory

Design and reporting of experimental investigations. Topics include instrument design equations, sources of error, and calibration. Survey of instruments to measure: voltage, resistance, current, time, frequency, displacement, velocity, acceleration, strain, force, and torque.

Credit Hours: 3

Prerequisites or Corequisites: MAE 3600 grade of C- or better

Prerequisites: grade of C- or better in ENGINR 2100 and ENGINR 2200 and Physics 2760; Restricted to Mechanical and Aerospace Engineering students only

MAE 3900: Mechanism Design

Analysis of kinematics and dynamics of machinery. Topics include design and selection of various mechanisms. Graded on A-F basis only.

Credit Hours: 3

Prerequisites: Grade of C- or better in MAE 2600 and MAE 3100.

Restricted to Mechanical and Aerospace Engineering students only

MAE 4001: Topics in Mechanical and Aerospace Engineering

Current and new technical developments in mechanical and aerospace engineering. Enrollment limited to Mechanical and Aerospace Engineering students only.

Credit Hours: 3

Prerequisites: instructor's consent

MAE 4085: Problems in Mechanical and Aerospace Engineering

Special design, experimental and analytical problems in mechanical and aerospace engineering.

Credit Hour: 1-99

Prerequisites: Instructor's consent

MAE 4210: Aerospace Structures

(cross-leveled with MAE 7210). Fundamentals of the mechanics and design issues of aerospace structures. Analysis of thin skins with stiffeners for external surfaces, bulkheads and frames for shape support, and fasteners for holding components together. Graded on A-F basis only.

Credit Hours: 3

Prerequisites: C- or better in ENGINR 2200

MAE 4220: Materials Selection

(cross-leveled with MAE 7220). Study of the physical and mechanical metallurgy of alloy systems of interest in engineering applications.

Credit Hours: 3

Prerequisites: C- or better in MAE 3200; Restricted to Mechanical and Aerospace Engineering students only

MAE 4230: Nanomaterials

(cross-leveled with MAE 7230). The primary goal of this course is to introduce students into the new field of nanostructured materials. The emphasis of the course is to introduce the students into synthesis and characterization of nanomaterials, the behavior of such materials with nanoscale structures, and their technological applications.

Credit Hours: 3

Prerequisites: C- or better in MAE 3200 or equivalent

MAE 4230W: Nanomaterials - Writing Intensive

(cross-leveled with MAE 7230). The primary goal of this course is to introduce students into the new field of nanostructured materials. The emphasis of the course is to introduce the students into synthesis and characterization of nanomaterials, the behavior of such materials with nanoscale structures, and their technological applications.

Credit Hours: 3

Prerequisites: C- or better in MAE 3200 or equivalent

MAE 4231: Transport Phenomena in Materials Processing

(same as BIOL_EN 4231; cross-leveled with BIOL_EN 7231, MAE 7231). Applications of fluid flow, heat transfer, and mass transfer in steady-state and unsteady-state materials processing with applications to metals, polymers, and ceramics. Graded on A-F basis only.

Credit Hours: 3

Prerequisites or Corequisites: MAE 4300

Prerequisites: C- or better in Math 4100

MAE 4232: Ceramic Materials and Processing

(cross-leveled with MAE 7232). Treatment of ceramics materials, structure, and ceramic processing with hands-on demonstration/labs. Graded on A-F basis only.

Credit Hours: 3

Prerequisites: C- or better in MAE 3200

MAE 4250: Composite Materials

(cross-leveled with MAE 7250). A survey of composite materials used in engineering emphasizing fiber-reinforced composites but including laminate and particulate composites.

Credit Hours: 3

Prerequisites: C- or better in MAE 3200. Restricted to Mechanical and Aerospace Engineering students only

MAE 4270: Nondestructive Evaluation of Materials

(cross-leveled with MAE 7270). The role of nondestructive evaluation (NDE) in engineering is explored. Ultrasonic NDE is studied in detail. Labs are used to support the study of ultrasonic NDE. Other NDE techniques are surveyed.

Credit Hours: 3

Prerequisites: C- or better in MAE 3200, Mechanical and Aerospace Engineering students only

MAE 4280: Introduction to Finite Element Methods

(cross-leveled with MAE 7280). The application of matrix operations, energy concepts and structural mechanics to the development of the finite element method. Application of finite element method to beams, frames and trusses.

Credit Hours: 3

Prerequisites: C- or better in ENGINR 2200, MAE 3100, MAE students only

MAE 4290: Welding Engineering

(cross-leveled with MAE 7290). Welding is the most common method of joining similar as well as dissimilar materials. This course thus introduces the basic science and engineering aspects of commonly used fusion and non-fusion welding processes. Stress analysis and failure to welded joints is also introduced to develop safe and durable welded structures.

Credit Hours: 3

Prerequisites: senior standing in Mechanical and Aerospace Engineering

MAE 4300: Heat Transfer

Fundamentals of conduction, convection and radiation. Use of nondimensional parameters. Theory and design of simple heat exchangers.

Credit Hours: 3

Prerequisites: Grade of C- or better in MAE 2300 and MAE 3400. Restricted to Mechanical and Aerospace Engineering students only

MAE 4310: Intermediate Heat Transfer

(cross-leveled with MAE 7310). Advanced topics in conduction, convection, and radiation. Heat exchanges and their applications will also be analyzed.

Credit Hours: 3

Prerequisites: C- or better in MAE 4300 and Mechanical Engineering students only

MAE 4320: Design of Thermal Systems

(cross-leveled with MAE 7320). Thermal systems are simulated by mathematical models (often on a digital computer), followed by optimization. Supporting topics include: economics, heat transfer, thermodynamics, and optimization.

Credit Hours: 3

Prerequisites: C- or better in MAE 4300

MAE 4320W: Design of Thermal Systems - Writing Intensive

Thermal systems are simulated by mathematical models (often on a digital computer), followed by optimization. Supporting topics include: economics, heat transfer, thermodynamics, and optimization.

Credit Hours: 3

Recommended: MAE 4300

MAE 4325: Nanoscale Energy Transport

(cross-leveled with MAE 7325). This course examines non-equilibrium energy processes from the vantage point of fundamental energy carriers. Topics include foundational solid state physics, statistical energy carrier distributions, density of states, and dispersion relationships. Energy transport will be discussed in terms of kinetic theory, the Landauer Formalism, and the Boltzmann Transport Equation. Graded on A-F basis only.

Credit Hours: 3

Prerequisites: Senior standing in MAE

MAE 4340: Heating and Air Conditioning

(cross-leveled with MAE 7340). General principles of thermal science applied to the design of environmental control systems. Topics covered include heating and cooling load calculations, annual operating and life cycle cost estimating, duct and pipe sizing, and equipment selection.

Credit Hours: 3

Prerequisites: C- or better in MAE 4300 and MAE students only

MAE 4350: Industrial Energy Analysis

(cross-leveled with MAE 7355). Energy use in industrial systems: furnaces, boilers, compressors, motors, lighting, etc. Insulation in building envelopes. Renewable energy sources. Energy auditing and economic analysis. Graded on A-F basis only.

Credit Hours: 3

Prerequisites or Corequisites: MAE 4300

MAE 4380: Intermediate Thermodynamics

(cross-leveled with MAE 7380). Topics from classical and statistical thermodynamics.

Credit Hours: 3

Prerequisites: C- or better in MAE 2300

MAE 4390: Aerospace Propulsion

(cross-leveled with MAE 7390). Analysis of aircraft engines and spacecraft propulsion systems.

Credit Hours: 3**Prerequisites:** C- or better in MAE 3400 and Junior standing in Mechanical and Aerospace Engineering

MAE 4420: Intermediate Fluid Mechanics

(cross-leveled with MAE 7420). Topics in potential and viscous flow theory, and computational fluid dynamics.

Credit Hours: 3**Prerequisites:** C- or better in MAE 3400

MAE 4430: Introduction to Computational Fluid Dynamics and Heat Transfer

(cross-leveled with MAE 7430). Introduction to the principles and development of the finite difference approximations to the governing differential equations of viscous and inviscid fluid flow, as well as heat transfer. Introduction to discretization methods and the calculation of flow fields, convection, diffusion and conduction.

Credit Hours: 3**Prerequisites:** C- or better in MAE 3400

MAE 4440: Aerodynamics

(cross-leveled with MAE 7440). Presents fundamentals of wing and airfoil theory for incompressible flow, including fluid kinematics and dynamics, potential flow, flow about a body, thin-airfoil theory, and finite wing.

Credit Hours: 3**Prerequisites:** C- or better in MAE 3400

MAE 4450: Gas Dynamics

(cross-leveled with MAE 7450). One dimensional compressible flow with and without friction and heat transfer. Isentropic flow and shock phenomenon in nozzles and diffusers.

Credit Hours: 3**Prerequisites:** C- or better MAE 3400

MAE 4460: Microfluidics

(cross-leveled with MAE 7460). This course focuses on liquid transport in micro/nano fluidic devices and related electrohydrodynamics. Graded on A-F basis only.

Credit Hours: 3**Recommended:** MAE 3400

MAE 4500: Manufacturing Methods

Introduction to manufacturing processes with emphasis on those aspects most relevant to methods, problems in force analysis, and practicum and experimentation in machine tool applications.

Credit Hours: 3**Prerequisites:** Grade of C- or better in ENGINR 1110 and MAE 3200. Restricted to Mechanical and Aerospace Engineering students only

MAE 4600: Advanced Mechanics of Materials

(same as CV_ENG 4600; cross-leveled with MAE 7600 and CV_ENG 7600). Analysis of more complicated problems in stresses, strains.

Credit Hours: 3

Prerequisites: C- or better in ENGR 2200, MAE 3200 and Junior standing in MAE

MAE 4620: Aircraft Flight Performance

(cross-leveled with MAE 7620). Analysis of aircraft flight and aircraft performance metrics. Topics include airplane aerodynamics and propulsion, steady flight, range, endurance, take-off and landing, and aircraft maneuvers. Graded on A-F basis only.

Credit Hours: 3**Prerequisites:** C- or better in MAE 2600, MAE 3100, MAE 3400, and Junior standing in Mechanical and Aerospace Engineering

MAE 4630: Space Flight Mechanics

(cross-leveled with MAE 7630). Analysis of spacecraft orbits and trajectories. Topics include orbital mechanics, orbital maneuvers, interplanetary missions, and entry flight mechanics.

Credit Hours: 3**Prerequisites:** C- or better in MAE 2600, MAE 3100, and Junior standing in Mechanical and Aerospace Engineering

MAE 4660: Vibration Analysis

(same as CV_ENG 4660; cross-leveled with MAE 7660, CV_ENG 7660). Vibration theory and its application to mechanical systems. Topics include free and forced vibration analysis of single- and multi-degree of freedom systems.

Credit Hours: 3**Prerequisites:** C- or better in MATH 4100 and MAE 2600

MAE 4680: Introduction to MEMS

(cross-leveled with MAE 7680). The course will start with a survey of the widespread applications of MEMS sensors and actuators. Micro fabrication methods used in conventional semiconductor industry will be introduced. MEMS-specific process will be emphasized. Fundamental principles in electric circuits and mechanics will be reviewed. Special attention is on mechanical issues encountered in MEMS design and fabrication.

Credit Hours: 3**Prerequisites:** C- or better in MAE 3600 and Junior standing in Mechanical and Aerospace Engineering

MAE 4690: Aircraft Flight Dynamics

(cross-leveled with MAE 7690). Introduction to atmospheric flight mechanics, Static stability, Dynamic stability, Aircraft coordinate systems, Aircraft equations of motion, Small perturbation Analysis and Linearization, Aerodynamic force and moment representations, Longitudinal motion, Lateral/directional motion, Introduction to flight controls. Graded on A-F basis only.

Credit Hours: 3**Prerequisites:** C- or better in MAE 2600, MAE 3100, and MAE 3400 and Junior Standing in Mechanical and Aerospace Engineering

MAE 4710: Hydraulic Control System

(cross-leveled with MAE 7710). Analysis of hydraulic control components and systems. Topics include pumps, valves, actuators, and industrial and mobile control systems. May be repeated for credit. Graded on A-F basis only.

Credit Hours: 3

Prerequisites: C- or better in MAE 3400, MAE 3600, and Junior standing in Mechanical and Aerospace Engineering

MAE 4720: Modern Control

(cross-leveled with MAE 7720). Analysis and design of control systems using state-space methods. Topics include controllability and observability, feedback control using pole-placement, state observers, optimal linear-quadratic feedback control, and optimal estimation. Graded on A-F basis only.

Credit Hours: 3

Prerequisites: C- or better in MAE 3600 and Junior standing in Mechanical and Aerospace Engineering

MAE 4730: Mechatronics

(cross-leveled with MAE 7730). Design of systems which require the integration of mechanical and electronic components. Topics include microcontrollers, sensors, actuators, mechanical systems, real time control system programming, and modeling of electronic and mechanical systems.

Credit Hours: 3

Prerequisites: C- or better in MAE 3600 and Junior standing in Mechanical and Aerospace Engineering

MAE 4740: Digital Control

(cross-leveled with MAE 7740). Design and analysis of control systems using discrete-time methods. Topics include z-transforms, sampling and reconstruction, stability analysis, and digital controller design.

Credit Hours: 3

Prerequisites: C- or better in MAE 3600 and Junior standing in Mechanical and Aerospace Engineering

MAE 4750: Classical Control

(same as BIOL_EN 4310, ECE 4310; cross-leveled with MAE 7750, BIOL_EN 7310, ECE 7310). Study of feedback control design based on classical continuous-time methods. Topics include performance specifications, stability analysis, root locus compensator design, and frequency domain analysis and compensator design.

Credit Hours: 3

Prerequisites: C- or better in MATH 4100

MAE 4800: Applied Thermal/Fluids Laboratory

Applied thermal and fluid systems, such as HVAC and psychometrics, will be introduced. Experiments conducted on thermal/fluid hardware components will be used to reinforce concepts.

Credit Hours: 4

Prerequisites: Grade of C- or better in MAE 4300. Restricted to Mechanical and Aerospace Engineering students only

MAE 4800W: Applied Thermal/Fluids Laboratory - Writing Intensive

Applied thermal and fluid systems, such as HVAC and psychometrics, will be introduced. Experiments conducted on thermal/fluid hardware components will be used to reinforce concepts.

Credit Hours: 4

Prerequisites: Grade of C- or better in MAE 4300. Restricted to Mechanical and Aerospace Engineering students only

MAE 4825: Materials and Manufacturing Laboratory

Experiments in materials characterization, material properties, and manufacturing processes.

Credit Hour: 1-3

Prerequisites or Corequisites: MAE 4500

Prerequisites: C- or better in MAE 3800, Restricted to Mechanical and Aerospace Engineering students only

MAE 4900: Machine Element Design

Application of stress and fatigue analyses to the design of machine elements such as fasteners, springs, shafts, and gears. Topics include selection of appropriate materials and machine elements.

Credit Hours: 3

Prerequisites: Grade of C- or better in MAE 3200. Restricted to Mechanical and Aerospace Engineering students only

MAE 4930: Applied Mechanical Optimization

(cross-leveled with MAE 7930). Introduction to mathematical programming techniques and applications to the design of mechanical systems and components.

Credit Hours: 3

Prerequisites: C- or better in MAE 3100, Mechanical and Aerospace Engineering students only

MAE 4940: Aircraft Design

(cross-leveled with MAE 7940). Conceptual design of aircraft, from initial sizing and design layout to design analysis, optimization and trade studies. Fundamental theories for aircraft design including sizing, aerodynamic forces, airfoil selection, wing loading, configuration layout payloads, propulsion systems, landing gear, aerospace structures, and cost analysis. Graded on A-F basis only.

Credit Hours: 3

Prerequisites: C- or better in ENGR 2200, MAE 3400, MAE 3600, and Junior standing in MAE

MAE 4980: Senior Capstone Design

Senior design experience. Topics include reliability, safety, manufacturability, economic, and environmental constraints; design case studies; and industrial design projects.

Credit Hours: 3

Prerequisites: Grade of C- or greater in MAE 3600, MAE 4500, MAE 4900 and STAT 4710 or IMSE 2110; Restricted to Mechanical and Aerospace Engineering students only

MAE 4980W: Senior Capstone Design - Writing Intensive

Senior design experience. Topics include reliability, safety, manufacturability, economic, and environmental constraints; design case studies; and industrial design projects.

Credit Hours: 3

Prerequisites: Grade of C- or greater in MAE 3600, MAE 4500, MAE 4900 and STAT 4710 or IMSE 2110; Restricted to Mechanical and Aerospace Engineering students only

MAE 4990: Undergraduate Research in Mechanical and Aerospace Engineering

Independent investigation or project in Mechanical Engineering. Enrollment limited to senior Mechanical and Aerospace Engineering students only.

Credit Hour: 0-6

Prerequisites: instructor's consent

MAE 4995: Undergraduate Honors Research Mechanical & Aerospace Engineering

Independent investigation to be presented as an undergraduate honors thesis. Enrollment limited to Honors Mechanical and Aerospace Engineering students only. Prerequisites: Consent required

Credit Hour: 1-99

MAE 4995W: Undergraduate Honors Research Mechanical & Aerospace Engineering - Writing Intensive

Independent investigation to be presented as an undergraduate honors thesis. Enrollment limited to Honors Mechanical and Aerospace Engineering students only. Prerequisites: Consent required

Credit Hour: 1-99

MAE 7001: Topics in Mechanical and Aerospace Engineering

Current and new technical developments in mechanical and aerospace engineering.

Credit Hours: 3

Prerequisites: instructor's consent

MAE 7210: Aerospace Structures

Fundamentals of the mechanics and design issues of aerospace structures. Analysis of thin skins with stiffeners for external surfaces, bulkheads and frames for shape support, and fasteners for holding components together. Graded on A-F basis only.

Credit Hours: 3

Prerequisites: grade of C or better in ENGINR 2200

MAE 7230: Nanomaterials

The primary goal of this course is to introduce students into the new field of nanostructured materials. The emphasis of the course is to introduce the students into synthesis and characterization of nanomaterials, the behavior of such materials with nanoscale structures, and their technological applications.

Credit Hours: 3

Prerequisites: MAE 3200 or equivalent

MAE 7231: Transport Phenomena in Materials Processing

(same as BIOL_EN 7231) Applications of fluid flow, heat transfer, and mass transfer in steady-state and unsteady-state materials processing with applications to metals, polymers, and ceramics. Graded A-F basis only.

Credit Hours: 3

Prerequisites: MAE 3200, MAE 3400, MAE 4300 (or equivalent courses) and MATH 4100

MAE 7232: Ceramic Materials and Processing

(cross-leveled with MAE 4232). Treatment of ceramics materials, structure, and ceramic processing with hands-on demonstration/labs. Graded on A-F basis only.

Credit Hours: 3

Prerequisites: MAE 3200 or equivalent course

MAE 7250: Composite Materials

A survey of composite materials used in engineering emphasizing fiber-reinforced composites but including laminate and particulate composites.

Credit Hours: 3

Prerequisites: MAE 3200

MAE 7270: Nondestructive Evaluation of Materials

The role of nondestructive evaluation (NDE) in engineering is explored. Ultrasonic NDE is studied in detail. Labs are used to support the study of ultrasonic NDE. Other NDE techniques are surveyed.

Credit Hours: 3

Prerequisites: MAE 3200

MAE 7280: Introduction to Finite Element Methods

(cross-leveled with MAE 4280). The application of matrix operations, energy concepts and structural mechanics to the development of the finite element method. Application of finite element method to beams, frames and trusses. Prerequisites: ENGINR 2200, MAE 3100, MAE students only.

Credit Hours: 3

Prerequisites: Restricted to Mechanical and Aerospace Engineering students only

MAE 7290: Welding Engineering

Welding is the most common method of joining similar as well as dissimilar materials. This course thus introduces the basic science and engineering aspects of commonly used fusion and non-fusion welding processes. Stress analysis and failure of welded joints is also introduced to develop safe and durable welded structures.

Credit Hours: 3

Prerequisites: senior standing or graduate level

MAE 7310: Intermediate Heat Transfer

Advanced topics in conduction, convection, and radiation. Heat exchanges and their applications will also be analyzed.

Credit Hours: 3

Prerequisites: MAE 4300

MAE 7320: Design of Thermal Systems

Thermal systems are simulated by mathematical models (often on a digital computer), followed by optimization. Supporting topics include: economics, heat transfer, thermodynamics, and optimization.

Credit Hours: 3

Prerequisites: MAE 4300

MAE 7340: Heating and Air Conditioning

General principles of thermal science applied to the design of environmental control systems. Topics covered include heating and cooling load calculations, annual operating and life cycle cost estimating, duct and pipe sizing, and equipment selection.

Credit Hours: 3

Prerequisites: MAE 4300

MAE 7355: Industrial Energy Analysis

Energy use in industrial systems: furnaces, boilers, compressors, motors, lighting, etc. Insulation in building envelopes. Renewable energy sources. Energy auditing and economic analysis. Graded on A-F basis only.

Credit Hours: 3

Corequisites: MAE 4300 or instructor's consent

MAE 7380: Intermediate Thermodynamics

Topics from classical and statistical thermodynamics.

Credit Hours: 3

Prerequisites: ENGINR 2300

MAE 7390: Aerospace Propulsion

Analysis of aircraft engines and spacecraft propulsion systems.

Credit Hours: 3

Prerequisites: MAE 3400

MAE 7420: Intermediate Fluid Mechanics

Topics in potential and viscous flow theory, and computational fluid dynamics.

Credit Hours: 3

Prerequisites: MAE 3400

MAE 7430: Introduction to Computational Fluid Dynamics and Heat Transfer

Introduction to the principles and development of the finite difference approximations to the governing differential equations of viscous and inviscid fluid flow, as well as heat transfer. Introduction to discretization methods and the calculation of flow fields, convection, diffusion and conduction.

Credit Hours: 3

Prerequisites: MAE 3400, MAE 4300 and MAE 4420

MAE 7440: Aerodynamics

Presents fundamentals of wing and airfoil theory for incompressible flow, including fluid kinematics and dynamics, potential flow, flow about a body, thin-airfoil theory, and finite wing.

Credit Hours: 3

Prerequisites: MAE 3100 and MAE 3400

MAE 7450: Gas Dynamics

One-dimensional compressible flow with and without friction and heat transfer. Isentropic flow and shock phenomenon in nozzles and diffusers.

Credit Hours: 3

Prerequisites: MAE 3400

MAE 7460: Microfluidics

(cross-leveled with MAE 4460). This course focuses on liquid transport in micro/nano fluidic devices and related electrohydrodynamics. Graded on A-F basis only.

Credit Hours: 3

Prerequisites: MAE 3400

MAE 7600: Advanced Mechanics of Materials

(same as CV_ENG 7600; cross-leveled with MAE 4600 and CV_ENG 4600). Analysis of more complicated problems in stresses, strains.

Credit Hours: 3

Prerequisites: C- or better in ENGR 2200, MAE 3200 and Junior standing in MAE

MAE 7620: Aircraft Flight Performance

(cross-leveled with MAE 4620). Analysis of aircraft flight dynamics and aircraft performance. Topics include airplane aerodynamics and propulsion, steady flight, flight performance, aircraft maneuvers, aircraft stability, and an introduction to flight controls. Graded on A-F basis only.

Credit Hours: 3

Prerequisites: MAE 3600

MAE 7630: Space Flight Mechanics

(cross-leveled with MAE 4630). Analysis of spacecraft motion. Topics include orbital dynamics, spacecraft attitude dynamics, satellite trajectory design, and spacecraft control system design.

Credit Hours: 3

Prerequisites: MAE 3600

MAE 7660: Vibration Analysis

(same as CV_ENG 7660). Vibration theory and its application to Mechanical systems. Topics include free and forced vibration analysis of single and multi-degree of freedom systems.

Credit Hours: 3

Prerequisites: C- or better in MATH 4100 and MAE 2600

MAE 7680: Introduction to MEMS

The course will start with a survey of the widespread applications of MEMS sensors and actuators. Micro fabrication methods used in conventional semiconductor industry will be introduced. MEMS-specific processes will be emphasized. Fundamental principles in electric circuits and mechanics will be reviewed. Special attention is on mechanical issues encountered in MEMS design and fabrication. Graded on A-F basis only.

Credit Hours: 3

MAE 7690: Aircraft Flight Dynamics

(cross-leveled with MAE 4690). Introduction to atmospheric flight mechanics, Static stability, Dynamic stability, Aircraft coordinate systems, Aircraft equations of motion, Small perturbation Analysis and Linearization, Aerodynamic force and moment representations, Longitudinal motion, Lateral/directional motion, Introduction to flight controls. Graded on A-F basis only.

Credit Hours: 3

MAE 7710: Hydraulic Control Systems

Analysis of hydraulic control components and systems. Topics include pumps, valves, actuators, and industrial and mobile control systems.

Credit Hour: 1-3

Prerequisites: MAE 3400 and MAE 3600

MAE 7720: Modern Control

Analysis and design of control systems using state-space methods. Topics include controllability and observability, feedback control using pole-placement, state observers, optimal linear-quadratic feedback control, and optimal estimation. Graded on A-F basis only.

Credit Hours: 3

Prerequisites: MAE 3600

MAE 7730: Mechatronics

Design of systems which require the integration of mechanical and electronic components. Topics include microcontrollers, sensors, actuators, mechanical systems, real time control system programming, and modeling of electronic and mechanical systems.

Credit Hours: 3

Prerequisites: MAE 3600

MAE 7750: Classical Control

(same as ECE 7310, BIOL_EN 7310; cross-leveled with MAE 4750, ECE 4310, BIOL_EN 4310). Study of feedback control design based on classical continuous-time methods. Topics include performance specifications, stability analysis, root locus compensator design, and frequency domain analysis and compensator design.

Credit Hours: 3

MAE 7930: Applied Mechanical Optimization

Introduction to mathematical programming techniques and applications to the design of mechanical systems and components.

Credit Hours: 3

Prerequisites: MAE 3100

MAE 7940: Aircraft Design

(cross-leveled with MAE 4940). Conceptual design of aircraft, from initial sizing and design layout to design analysis, optimization, and trade studies. Fundamental theories for aircraft design, including sizing, aerodynamic forces, airfoil selection, wing loading, configuration layout, payloads, propulsion systems, landing gear, aerospace structures, and cost analysis. Graded A-F basis only.

Credit Hours: 3

Prerequisites: MAE 3400, MAE 3600, MAE 3600

MAE 8001: Advanced Topics in Mechanical and Aerospace Engineering

Advanced Topics in Mechanical and Aerospace Engineering.

Credit Hours: 3

MAE 8085: Problems in Mechanical and Aerospace Engineering

Supervised investigation in mechanical and aerospace engineering to be presented in the form of a report.

Credit Hour: 1-99

MAE 8087: Graduate Seminar in Mechanical and Aerospace Engineering

Reviews recent investigations, projects of major importance in mechanical and aerospace engineering. Graded on S/U basis only.

Credit Hour: 1

MAE 8240: Mechanical Behavior of Materials

This course will cover the mechanical behavior of metallic, ceramic, polymeric, and composite materials and their relationships to the underlying microstructures. Graded on A-F basis only.

Credit Hours: 3

Prerequisites: MAE 3200 and graduate standing in engineering, or instructor's consent

MAE 8280: Finite Element Methods

(same as CV_ENG 8208). The concepts and fundamentals of the finite element method with applications to problems in solid and fluid mechanics.

Credit Hours: 3

Prerequisites: MAE 4280

MAE 8300: Microscale Heat Transfer

Review of existing models. Concept of thermal lagging and the second-law admissibility. Applications to low temperatures, thermal processing of thin-film devices; amorphous materials; advanced composites.

Credit Hours: 3

Prerequisites: MAE 4300

MAE 8311: Heat Transfer-Convection

Principles of heat transfer by convection, review of boundary layer theory, laminar and turbulent heat transfer, temperature-dependent fluid properties, high velocity heat transfer and an introduction to mass transfer.

Credit Hours: 3

Prerequisites: MAE 4300 and MAE 8410

MAE 8313: Heat Transfer-Conduction

Distribution of temperature and temperature history within solids by the four essential methods of evaluation of these temperature fields.

Credit Hours: 3

Prerequisites: MAE 4300

MAE 8315: Multiphase Heat Transfer

Fundamentals and application of heat and mass transfer and fluid flow with phase change; melting and solidification, sublimation and vapor deposition, condensation, evaporation, nucleate and film boiling, two-phase flow. Graded on A-F basis only.

Credit Hours: 3

Prerequisites: MAE 4300

MAE 8320: Continuum Mechanics

(same as CV_ENG 8320). Introductory course in the mechanics of continuous media. Basic concepts of stress, strain, constitutive relationships; conservation laws are treated using Cartesian tensor notation. Examples from both solid and fluid mechanics investigated.

Credit Hours: 3**Prerequisites:** MAE 3400, MATH 4100, ENGINR 2200

MAE 8330: Theory of Elasticity

(same as CV_ENG 8330). Stress and strain at a point. General equations of elasticity. Plane stress, plain strain problems; torsion of prismatic bars. Energy methods.

Credit Hours: 3

MAE 8332: Thermal Stresses

General equations of thermoelasticity, Constitutive equations of thermoelastoplasticity; Analytical and numerical analyses of thermal stresses in bars, beams, 3D media, 2D plane stress and strain media, cylinders, and spheres. Graded on A-F basis only.

Credit Hours: 3**Prerequisites:** MAE 4300, or instructor's consent**Recommended:** MAE 8330

MAE 8360: Theory of Plasticity

(same as CV_ENG 8360). Plastic yield conditions and stress-strain relations. Behavior of elastic-perfectly plastic members. Plain strain in plastic members.

Credit Hours: 3**Prerequisites:** MAE 8330 or instructor's consent

MAE 8380: Advanced Thermodynamics

Advanced topics from classical thermodynamics.

Credit Hours: 3**Prerequisites:** MAE 4380

MAE 8420: Computational Heat Transfer and Fluid Dynamics

Introduction to numeric analysis techniques applied to heat transfer and fluid dynamics problems. Coverage will include, the development of discretization equations for the control volume approach and solution strategies of those equations. Results from numeric simulations will be compared with close form analytic solutions and commercial numeric code output.

Credit Hours: 3

MAE 8430: Introduction to Two Phase Flow

An introduction to the analysis of the mechanics and transport processes in two phase flows.

Credit Hours: 3**Prerequisites:** MAE 3400

MAE 8450: Introduction to Turbulence

An introduction to the physical phenomena of turbulence, supported by mathematical and statistical descriptions. Especially appropriate for engineers involved in research of momentum, heat, and mass transport.

Credit Hours: 3**Prerequisites:** MAE 4420

MAE 8510: Manufacturing Design

Design for manufacture methods, their capabilities and applications. Design of intelligent manufacturing systems using sensory systems and artificial intelligence techniques.

Credit Hours: 3**Prerequisites:** MAE 3100 and MAE 4500

MAE 8620: Advanced Dynamics

(same as CV_ENG 8620). Fundamental principles of advanced rigid body dynamics with applications. Special mathematical techniques including Lagrangian and Hamiltonian methods.

Credit Hours: 3**Prerequisites:** MAE 2600

MAE 8740: Robust Control

Definition of the robust performance problem with the goal of achieving specified signal levels in the face of plant uncertainty; uncertainty and robustness, stabilization, design constraints, loopshaping, model matching and design for robust performance.

Credit Hours: 3**Prerequisites:** MAE 4750, and MAE 8780 or instructor's consent

MAE 8750: Nonlinear Control

Nonlinear systems analysis techniques including phase plane analysis, Lyapunov theory. Control design including feedback linearization, sliding control, and adaptive control.

Credit Hours: 3**Prerequisites:** MAE 4750 and MAE 8780

MAE 8760: Optimal Control

The course will study optimization under dynamic constraints and optimal control theory. Topics include calculus of variation, Pontryagin's minimum principle, dynamic programming, and linear quadratic optimal control. Graded on A-F basis only.

Credit Hours: 3

MAE 8910: Modular Machine Tool Design

This course introduces necessary concepts and tools for modular machine tool design. Students will learn how to apply mechanical design knowledge and commercially available subassemblies and parts to design modular machine tools for mass production application.

Credit Hours: 3**Prerequisites:** MAE 4980 or instructor's consent

MAE 8930: Advanced Mechanical System Modeling and Optimization

Calculus of variations is introduced as a basic tool. Hamilton's Principle is used for system modeling. Numerical solution methods are used for dynamic simulation. Genetic algorithm and other algorithms are applied for system optimization. Graded on A-F basis only.

Credit Hours: 3

Prerequisites: MAE 3600 and MAE 4980. Seniors will require consent

MAE 8990: Research-Masters Thesis in Mechanical and Aerospace Engineering

Independent investigation in field of mechanical and aerospace engineering to be presented as a thesis. Graded on a S/U basis only.

Credit Hour: 1-99

MAE 9990: Research-Doctoral Dissertation Mechanical & Aerospace Engineering

Independent investigation in field of mechanical and aerospace engineering to be presented as a thesis. Graded on a S/U basis only.

Credit Hour: 1-99
