Mechanical and Aerospace Engineering (MAE)

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.

Credit Hours: 3
Prerequisites: C or better in MATH 1500

MAE 1100H: Introduction to Computer Aided Design - Honors
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.

Credit Hours: 3
Prerequisites: C or better in MATH 1500. Honors eligibility required

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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

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MAE 2200: Engineering Materials
The nature of the structure of engineering materials. The relationship of material structure to physical properties. Mechanical behavior of engineering materials. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Grade of C- or better in ENGINR 1200 and C or better in CHEM 1320. Restricted to Mechanical and Aerospace Engineering students only

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MAE 2200W: 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. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Grade of C- or better in ENGINR 1200 and C or better in CHEM 1320. Restricted to Mechanical and Aerospace Engineering students only

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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 ENGINR 1050 and a C or better in PHYSCS 2750; restricted to MAE students only

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MAE 2500: Introduction to Manufacturing Processes
Introduction to the fundamentals of manufacturing processes including forming, machining, casting, and welding, with emphasis on material processing, manufacturing equipment, and design considerations for manufacturing. Students will be trained in machine-shop safety, and will apply engineering graphics to design a simple part, and then use basic machining processes to manufacture the part in the machine shop. Graded on A-F only.

Credit Hours: 3
Prerequisites: C- or better in MAE 1100 and PHYSCS 2750. Restricted to Mechanical and Aerospace Engineering students only

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MAE 2510: Manufacturing Practice
This course provides practical training on conventional manufacturing processes, including cutting, milling, hole making, etc. The students will learn hands-on technical skills and experience, ranging from components design on 3D CAD software, proficiency with instrument operations and component inspection, effective communication via schematic drawing and sketching, and by finishing a group project in a manufacturing lab. A-F grading only.

Credit Hour: 1
Prerequisites: C- or better in MAE 1100

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: 3
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 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. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Grade of C- or better in MAE 2300 or ENGINR 2300, Grade of C- or better in MAE 2600, Grade of C- or better in MATH 4100; Restricted to Mechanical and Aerospace Engineering students only

MAE 3500: Introduction to Manufacturing Methods
(same as ISE 3500). This course is an introduction to the engineering principles of manufacturing processes, ranging from traditional to state-of-the-art. The course will emphasize material processing, selection, and design considerations for manufacturing and will introduce critical aspects of manufacturing process engineering through a combination of lectures, videos, class discussions, and case studies to engage students. By the end of this course, the students are expected to learn the fundamentals of manufacturing and manufacturing processes. Graded on A-F basis only.

Credit Hours: 2
Prerequisites or Corequisites: ENGINR 2200
Prerequisites: Grade of C- or better in MAE 1100. 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: Grade of C- or better in PHYSCS 2760, 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: grade of C- or better in MATH 4100, STAT 4710, ENGINR 2100 and ENGINR 2200; Restricted to Mechanical and Aerospace Engineering students only

MAE 3910: 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. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Grade of C- or better in ENGINR 2200, MAE 1100 and MAE 2200/MAE 2200W. 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. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: See instructor provided prerequisites

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 2200; Restricted to Mechanical and Aerospace Engineering students only

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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 2200 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 2200 or equivalent

MAE 4231: Transport Phenomena in Materials Processing
(same as BIOL_EN 4231, CH_ENG 4231; cross-leveled with MAE 7231, CH_ENG 7231, 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 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 2200

MAE 4233: Polymer Materials and Engineering
(cross-leveled with MAE 7233). Introduction to polymers as engineering materials; basic concepts and characteristics of polymers; relationship of molecular conformation, structure and morphology to physical and mechanical properties; thermal transition; processing techniques; and polymer composites. Graded on A-F basis only.

Credit Hours: 3

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 2200. Restricted to Mechanical and Aerospace Engineering students only

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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 2200, Mechanical and Aerospace Engineering students only

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MAE 4280: Introduction to Finite Element Methods
(same as CV_ENG 4680; cross-leveled with MAE 7280, CV_ENG 7680). 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

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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

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MAE 4300: Heat Transfer
Fundamentals of conduction, convection and radiation. Use of nondimensional parameters. Theory and design of simple heat exchangers. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Grade of C- or better in MAE 3400. Restricted to Mechanical and Aerospace Engineering students only

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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

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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

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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 4371: Energy Systems and Resources
(same as ECE 4020, NU_ENG 4315; cross-leveled with ECE 7020, NU_ENG 7315, MAE 7371). Analysis of present energy usage in Missouri, USA and the world, evaluation of emerging energy technologies and trends for the future. Economics and environmental impact of the developed technologies. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: C- or better in ENGINR 2300

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

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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 4600: Advanced Mechanics of Materials
(same as CV_ENG 4600; cross-leveled with MAE 7600 and CV_ENG 7600). Advanced concepts, methodology and solution procedures in mechanics of materials, including the theories of stress and strain in three-dimensions, linear stress-strain-temperature relations, inelastic material behavior and energy methods, as well as selected topics such as torsion, nonsymmetrical bending and shear center for thin-wall beam cross sections. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: C- or better in ENGINR 2200 and Junior standing in MAE or CV_ENG

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 4635: Spacecraft Attitude Dynamics and Control
(cross-leveled with MAE 7635). Spacecraft attitude representations; Spacecraft rotational kinematics and dynamics; Attitude determination and sensors; Environmental torques; Attitude stabilization strategies with gravity gradient, single and dual spins; Attitude control with momentum exchange devices. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Grade of C- or better in MAE 3600

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 Systems
(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, CMP_SC 4315; cross-leveled with MAE 7750, BIOL_EN 7310, ECE 7310, CMP_SC 7315). 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 4825: Materials and Manufacturing Laboratory
Experiments in materials characterization, material properties, and manufacturing processes. Graded on A-F basis only.

Credit Hours: 3
Prerequisites or Corequisites: MAE 3800
Prerequisites: C- or better in MAE 2200, MAE 2510, and MAE 2500 or MAE 3500, Restricted to Mechanical and Aerospace Engineering students only

MAE 4834: 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. Graded on A-F basis only.

Credit Hours: 3
Prerequisites or Corequisites: MAE 3800
Prerequisites: Grade of C- or better in MAE 4300. Restricted to Mechanical and Aerospace Engineering students only

MAE 4834W: 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. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Grade of C- or better in MAE 3800 and MAE 4300. Restricted to Mechanical and Aerospace Engineering students only

MAE 4910: Mechanism Design
(cross-leveled with MAE 7910). 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
Recommended: MAE 1100

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

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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 ENGINR 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. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: C- or better in MAE 3600, MAE 3910, MAE 4825, and MAE 4834

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. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: C- or better in MAE 3600, MAE 3910, MAE 4825, and MAE 4834

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. Graded on A-F basis only.

Credit Hour: 1-6
Prerequisites: Consent required

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. Graded on A-F basis only. Prerequisites: Consent required

Credit Hour: 1-6

MAE 7001: Topics in Mechanical and Aerospace Engineering
Current and new technical developments in mechanical and aerospace engineering. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: See instructor provided prerequisites

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 7220: Materials Selection
(cross-leveled with MAE 4220). Study of the physical and mechanical metallurgy of alloy systems of interest in engineering applications.

Credit Hours: 3
Prerequisites: MAE 2200

MAE 7230: Nanomaterials
(cross-leveled with MAE 4230). 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 2200 or equivalent

MAE 7231: Transport Phenomena in Materials Processing
(same as BIOL_EN 7231, CH_ENG 7231; cross-leveled with MAE 4231, BIOL_EN 4231, CH_ENG 4231). 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 2200, 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 2200 or equivalent course

MAE 7233: Polymer Materials and Engineering
(cross-leveled with MAE 4233). Introduction to polymers as engineering materials; basic concepts and characteristics of polymers; relationship of molecular conformation, structure and morphology to physical and mechanical properties; thermal transition; processing techniques; and polymer composites. Graded on A-F basis only.

Credit Hours: 3

MAE 7250: Composite Materials
(cross-leveled with MAE 4250). A survey of composite materials used in engineering emphasizing fiber-reinforced composites but including laminate and particulate composites.

Credit Hours: 3
Prerequisites: MAE 2200

MAE 7270: Nondestructive Evaluation of Materials
(cross-leveled with MAE 4270). 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 2200

MAE 7280: Introduction to Finite Element Methods
(same as CV_ENG 7680; cross-leveled with MAE 4280, CV_ENG 4680). 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: ENGINR 2200, MAE 3100, MAE students only. Restricted to Mechanical and Aerospace Engineering students only

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MAE 7290: Welding Engineering
(cross-leveled with MAE 4290). 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 or graduate level

MAE 7310: Intermediate Heat Transfer
(cross-leveled with MAE 4310). 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
(cross-leveled with MAE 4320). 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 7325: Nanoscale Energy Transport
(cross-leveled with MAE 4325). 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

MAE 7340: Heating and Air Conditioning
(cross-leveled with MAE 4340). 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
(cross-leveled with MAE 4350). 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 7371: Energy Systems and Resources
(same as ECE 7020, NU_ENG 7315; cross-leveled with ECE 4020, NU_ENG 4315, MAE 4371). Analysis of present energy usage in Missouri, USA and the world, evaluation of emerging energy technologies and trends for the future. Economics and environmental impact of the developed technologies.

Credit Hours: 3

MAE 7380: Intermediate Thermodynamics
(cross-leveled with MAE 4380). Topics from classical and statistical thermodynamics.

Credit Hours: 3
Prerequisites: ENGINR 2300

MAE 7390: Aerospace Propulsion
(cross-leveled with MAE 4390). Analysis of aircraft engines and spacecraft propulsion systems.

Credit Hours: 3
Prerequisites: MAE 3400

MAE 7420: Intermediate Fluid Mechanics
(cross-leveled with MAE 4420).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
(cross-leveled with MAE 4430). 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
(cross-leveled with MAE 4440). 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
(cross-leveled with MAE 4450). 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). Advanced concepts, methodology and solution procedures in mechanics of materials, including the theories of stress and strain in three-dimensions, linear stress-strain-temperature relations, inelastic material behavior and energy methods, as well as selected topics such as torsion, nonsymmetrical bending and shear center for thin-wall beam cross sections. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: C- or better in ENGINR 2200

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 7635: Spacecraft Attitude Dynamics and Control
(cross-leveled with MAE 4635). Spacecraft attitude representations; Spacecraft rotational kinematics and dynamics; Attitude determination and sensors; Environmental torques; Attitude stabilization strategies with gravity gradient, single and dual spins; Attitude control with momentum exchange devices. Graded on A-F basis only.

Credit Hours: 3

MAE 7660: Vibration Analysis
(same as CV_ENG 7660; cross-leveled with CV_ENG 4660, MAE 4660). 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
(cross-leveled with MAE 4680). 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
(cross-leveled with MAE 4710). 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
(cross-leveled with MAE 4720). 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
(cross-leveled with MAE 4730). 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, CMP_SC 7315; cross-leveled with MAE 4750, ECE 4310, BIOL_EN 4310, CMP_SC 4315). 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 7910: Mechanism Design
(cross-leveled with MAE 4910). Analysis of kinematics and dynamics of machinery. Topics include design and selection of various mechanisms. Graded on A-F basis only.

Credit Hours: 3

MAE 7930: Applied Mechanical Optimization
(cross-leveled with MAE 4930). 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 2200 and graduate standing in engineering, or instructor's consent

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MAE 8250: Plasma Technology for Materials Engineering
The course is intended to give graduate students a fundamental knowledge of plasma-assisted materials processing and an understanding of state-of-the-art plasma processing technology and applications. The content is designed for graduate students from materials science, mechanical engineering, chemical engineering, electrical engineering, etc. Graded on A-F basis only.

Credit Hours: 3

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

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 8340: Theory of Plates and Shells
(same as CV_ENG 8340). Rectangular and circular plates. Variational methods in the analysis of plates and shells. Plates of unusual shape. Shear deformation effects. Large deformation analysis. Analysis of cylindrical shells.

Credit Hours: 3

MAE 8350: Theory of Elastic Stability
(same as CV_ENG 8350). Buckling of Columns, frames, arches and other structural systems. Kinematic approach to stability. Large deflections. Energy approach to buckling. Plate and shell buckling. Inelastic buckling of columns. Creep buckling.

Credit Hours: 3

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 8392: Dynamics of Structures
(same as CV_ENG 8392). Study of the dynamic behavior of structures. Analysis of equivalent lumped parameter systems for the design of structures in a dynamic environment.

Credit Hours: 3
Prerequisites: CV_ENG 8390 or equivalent, proficiency in digital computer programming, or instructor's consent

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 discretiization 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 8460: Heat Pipes
Physics and interfacial phenomena, fundamentals of phase change heat transfer, mechanisms and heat transfer limitations of heat pipes, heat pipe fabrication and applications. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: MAE 4300

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 3500

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 8710: Advanced Hydraulic Control Systems
The course will focus on the study of hydraulic systems and the design and analysis of controls for these systems. Multivariable as well as single input single output techniques will be considered. Graded on A-F basis only.

Credit Hours: 3
Recommended: Undergraduate system dynamics and controls course, experience or coursework in basic hydraulic control systems such as MAE 4710 or MAE 7710

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

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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

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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
