Fall 2020 Course Descriptions as of 04/05/2020 08:10 PM

Information in Browse Course Catalog is subject to change. Information is term specific. Please refer to the appropriate term when searching for course content. Key to Course Descriptions may be found at: **http://rcs.registrar.arizona.edu/course_descriptions_key**.

Aerospace & Mechanical Engr (AME)

AME 105: Introduction to MATLAB I (1 unit)
Description: The MATLAB programming environment, arrays, creating and running script files, 2D plotting features, functions, programming elements, polynomials, curve fitting, and interpolation.
Grading basis: Regular Grades
Career: Undergraduate

Course Components:	Laboratory	Required
	Lecture	Required

Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Math 109C or Math 111 or Math 112 or Math 113 or Math 120R or Math 122B or Math 125.

AME 170B1: Aeronautics: Science and People (3 units)
Description: Examination of the evolution of flight from birds to space shuttles. The examination of flight will focus on the observations of experimental facts and discussions of physical principles. It will also address historical events and stories of pilots, astronauts, engineers, and scientists. The role of individuals in the development of aeronautics will be emphasized.
Grading basis: Regular Grades
Career: Undergraduate

Course Components:	Discussion	May Be Offered
	Lecture	Required

Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Enrollment not allowed if you have previously taken NATS 102 "Aeronautics: Science and People" (Topic 1).
General Education: NATS 102

AME 195D: Our Future in Space and Space in Our Future (1 unit)
Description: The aim of this colloquium is to familiarize interested participants with the exciting future in space. This will go beyond the usual gee-whiz pictures and animations that abound in the news media, or the spectacular pictures available on the internet sites. Through the eight major components that make up space systems, the students will be introduced to the subject as an integrated whole, rather than disjointed segments. After the colloquium, the informed audience will be able to make intelligent choices regarding career majors, will develop a realistic feel for what is involved in space ventures and missions, and how it affects the future for all of us in everyday life, here on earth. Tours of some of the unique space laboratories on campus will complement the colloquium.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Colloquium Required
Equivalent to: ENGR 195D
Course typically offered:
Main Campus: Fall

Field trip: Field trips
Freshman Colloquia: Freshman Colloquia

AME 199: Independent Study (1 - 3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

AME 205: Introduction to MATLAB II (1 unit)
Description: Two-dimensional arrays, manipulation of arrays, plots with special graphics, 3D plots, inline functions, solving a nonlinear equation with one variable, finding the maximum or minimum of a function.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Laboratory Required
Lecture Required
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: AME 105

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

AME 211: Computer-Aided Drafting and Manufacturing (3 units)
Description: The aim of this course is to provide the students with fundamentals in mechanical drafting and how it relates to manufacturing (CNC and additive manufacturing) and modern computational tools such as finite element analysis. SolidWorks will be used as the main learning and practice tool.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall, Spring

Field trip: NONE
Enrollment requirement: MATH 122B.

AME 220: Introduction to Aerospace Engineering (3 units)
Description: Introduction to airplanes and space vehicles as aerospace systems. Fundamentals that describe these systems. Elements of aerodynamics, airfoils and wings. Airplane performance, stability, and control. Aircraft and rocket propulsion. Fundamentals of orbital motion. Aspects of vehicle conceptual design.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: PHYS 141 and MATH 223. Prerequisite or concurrent enrollment in MATH 254.

AME 230: Thermodynamics (3 units)
Description: Basic laws and examples of engineering applications of macroscopic thermodynamics; equations of state; reversible and irreversible processes.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: PHYS 141 or PHYS 161H.

AME 250: Dynamics (3 units)
Description: Dynamics of particles and rigid bodies as applied to mechanical systems.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: CE 214. Prerequisite or concurrent enrollment in MATH 254.

AME 293: Internship (1 - 3 units)
Description: Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

AME 299: Independent Study (1 - 3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

AME 300: Instrumentation Laboratory (3 units)
Description: Basic principles of laboratory practice and instrumentation; statistical measurement theory including probability distributions, finite statistics, uncertainty analysis regression analysis dynamics of measurement systems; transducers and signal conditioning circuits. Experiments using basic laboratory instrumentation on the speed of sound, temperature measurements, and the dynamic response of first and second order systems.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $50
Course Components: Laboratory Required
Lecture Required
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Prerequisite or concurrent registration, AME 331. AME 230, ECE 207. Adv Stdg: Engineering.

AME 301: Engineering Analysis (3 units)
Description: Linear algebra, matrix eigenvalue problems, Fourier series, eigenfunctions, Laplace and Fourier transforms, and applications to ordinary and partial differential equations.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Enrollment requirement: MATH 254. Adv Stdg: Engineering.

AME 302: Numerical Methods (3 units)
Description: Introduction to linear algebra; solution of engineering problems based upon an integrated approach combining numerical analysis and the use of computers.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: AME 205, AME 250, and MATH 254. Prerequisite or concurrent enrollment in AME 301. Adv Stng: Engineering.

AME 313: Aerospace/Mechanical Engineering Laboratory (1 unit)
Description: This course is designed to teach students practical approaches and limitations of manufacturing with an emphasis on metal working processes. Students begin with instruction on shop safety practices which includes OSHA standards/industrial safety as well as machine-specific safety practices. The students are then introduced to basic metal working techniques such as layout, use of hand tools, as well as set-up and operation of manual metalworking equipment including the metal lathe and milling machine. The students are introduced to the limitations of metal working through a discussion of the material removal process.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $100
Course Components: Laboratory Required
Repeatable: Course can be repeated a maximum of 2 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

Enrollment requirement: Adv Stdg: Engineering.

AME 313B: Practical Aspects of Manual Machining (1 unit)
Description: The goal of this course is to teach students the fundamentals of manual machining to enhance their ability to fabricate prototype hardware. Prototyping on manual machines requires a fundamental understanding of how to utilize the instrumentation of the manual milling machine, the digital readout, to produce accurately machined parts. The metal lathe also utilizes a digital readout, but careful operation of the XZ dial system along with the use of the compound slide to produce intricate round parts will be emphasized. For both types of machines, the student will be introduced to proper work holding, tool selection (both geometry and materials), cutting speeds and feeds, surface finish, and tolerancing.
Grading basis: Regular Grades
Career: Undergraduate
Other Fee: This course is pending a course fee review from ABOR and the fee is subject to change if approved.
Course Components: Laboratory Required
Course typically offered:
Main Campus: Fall, Spring

Field trip: None.

AME 313C: Composite Materials Manufacturing Methods (1 unit)
Description: This course provides hands-on composite design considerations, material handling, safety and manufacturing techniques. The composite engineering life cycle will be demonstrated and then performed by the student while focusing on material safety.
Grading basis: Regular Grades
Career: Undergraduate
Other Fee: This course is pending a course fee review from ABOR and the fee is subject to change if approved.
Course Components: Laboratory Required
Course typically offered:
Main Campus: Fall, Spring

Recommendations and additional information: AME 313.
Field trip: None

AME 320: Aerodynamics (3 units)
Description: Basic equations and their approximation; potential flow theory; fundamentals of airfoil and wing theory; viscous and compressibility effects; an introduction to compressible flows; application to aerodynamics of wings and bodies.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Enrollment requirement: AME 331 or AME 220, and AME 301, Adv Stdg: Engineering.

AME 321: Aircraft Performance (3 units)
Description: Properties of the atmosphere, concepts in airflow and propulsion, airfoils and wings, airplane performance; energy methods.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: AME 250, and AME 331 or AME 220. Prerequisite or concurrent enrollment in AME 320. Adv Stng: Engineering

AME 323: Gasdynamics (3 units)
Description: Isentropic flow with area changes, normal and oblique shocks, one-dimensional flows with friction and heat addition, choking, method of characteristics, applications.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: MATH 254, and AME 230, and AME 331 or AME 220. Prerequisite or concurrent enrollment in AME 302. Adv Stng: Engineering.

AME 324A: Mechanical Behavior of Engineering Materials (3 units)
Description: Introduction to engineering solid materials; concepts of strain, stress, equilibrium; material/structural responses to applied loading/deflection; analysis of engineering components, e.g., beams, plates, thin-walled structures, axisymmetric elements; introduction to structural stability.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Enrollment requirement: CE 214 and Adv Stdg: Engineering.

AME 324B: Engineering Component Design (3 units)
Description: Application of failure analysis methods to the design of specific machine components such as shaft, gear sets, bolted/riveted/welded joints, spring and slender/thin-walled structures.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: AME 324A or CE 215; Adv Stng: Engineering.

AME 324C: Aerospace Structures (3 units)
Description: Application of principles of mechanics to the structural analysis of aerospace components. Topics covered include analysis of stress and strain, constitutive relations, plane problems of elasticity, torsion, bending, elastic stability, energy methods, and finite element methods.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: Adv Stdg: Engineering. AME 301 and AME 324A.

AME 324L: Mechanics of Materials Laboratory (1 unit)
Description: Characterization of engineering materials for stress-strain relations, deformation, hardness, strength, fracture, and cyclic fatigue. The course comprises of hands-on experience with instruments, specimens, recording and interpretation of data, and formal engineering report writing.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $50
Course Components: Laboratory Required
Lecture May Be Offered
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Prerequisite or concurrent enrollment in AME 324A or CE 215 or MSE 331R. Adv Stng: Engineering

AME 331: Introduction to Fluid Mechanics (3 units)
Description: Fundamentals of fluid mechanics covering properties of fluids, fluid statics, dynamics of incompressible viscous and inviscid flows, control volume formulations of continuity, momentum and energy equations, dimensional analysis, viscous pipe flow, boundary layers and drag.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Also offered as: BME 331
Course typically offered:
Main Campus: Fall

Enrollment requirement: AME 230 (or ABE 284 for BME and BE majors only), AME 250 (or PHYS 141 for BME majors only), and MATH 254. Adv Stdg: Engineering.

AME 352: Dynamics of Machines (3 units)
Description: Analysis of motions and forces in machines, design exercises.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Enrollment requirement: Adv Stdg: Engineering, AME 205 and AME 250.

AME 392: Directed Research (1 - 6 units)
Description: Individual or small group research under the guidance of faculty.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated for a maximum of 12 units.
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Adv Stdg: Engineering.
Student Engagement Activity: Discovery
Student Engagement Competency: Innovation and Creativity

AME 399: Independent Study (1 - 3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

Enrollment requirement: Adv Stdg: Engineering.

AME 399H: Honors Independent Study (1 - 3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

Enrollment requirement: Adv Stdg: Engineering. Honors active.
Honors Course: Honors Course
Honors Course: Honors Course

AME 400: Senior Mechanical Laboratory (2 units)
Description: Investigations involving thermal power and mechanical systems.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $50
Course Components: Laboratory Required
Lecture Required
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: AME 300 and Adv Stdg: Engineering.
Writing Emphasis: Writing Emphasis Course

AME 401: Senior Aerospace Laboratory (2 units)
Description: Laboratory investigations involving aerodynamic, control, structural, and power systems.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $50
Course Components: Laboratory Required
Course typically offered:
Main Campus: Fall

Enrollment requirement: AME 300 and AME 320 and AME 323. Adv Stdg: Engineering.
Writing Emphasis: Writing Emphasis Course

AME 410: Introduction to Additive Manufacturing (3 units)
Description: Additive Manufacturing (AM), as defined by ASTM International Committee F42, is the process of joining materials to make objects from three-dimensional (3D) model data, usually layer by layer, as opposed to subtractive manufacturing methodologies. Traditional manufacturing processes are subtractive, creating the object by machining, forming, casting, etc. AM converts computer-aided design (CAD) models to Standard Tessellation Language (STL), the de facto standard. The STL file describes the external closed surfaces of the original CAD model and forms the basis for calculation of the slices. Thus, it can be used to construct the 3D objects layer by layer using various materials (e.g. metallic, plastic). In this course, engineering materials and their properties are first reviewed. Traditional manufacturing such as casting, forming, machining, and joining processes are introduced and discussed. Additive manufacturing is then presented. Both general process chain and specific processes are presented (e.g. photopolymerization, powder bed fusion process). Materials properties of each manufacturing process are examined and compared to each other. Design and optimization for AM is highlighted. Real engineering applications are reviewed and discussed. A final project is required so that student can gain experiences in the entire AM process.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $100
Course Components: Laboratory Required
Lecture Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: Advanced Standing in Engineering required. Course Prerequisites: AME 313, MSE 331R, and (BE 221 OR AME 211).

AME 420: Aerospace Conceptual Design (3 units)
Description: Phases of design; take-off weight, Breguet method; sizing to stall speed requirements; sizing to landing distance; sizing to climb requirements; maneuvering; cruise requirements; landing distance sizing; summary of matching results; selection of overall configuration; aircraft of unusual configurations. Students form teams to work on industry-sponsored projects. Preliminary design review by end of the semester.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: AME 520
Course typically offered:
Main Campus: Fall

Enrollment requirement: Adv Stdg: Engineering. AME 313, AME 320, AME 321, and AME 323.

AME 422: Aerospace Engineering Design (3 units)
Description: Students work in teams on industry-sponsored design projects. Aerospace vehicle engineering design process. Determination of load factors, flight envelops, aerodynamic and inertial loads. Material selection. Structural analysis of wing, fuselage, and landing gear. Structure failure criteria. Critical review of senior design project at the middle of the semester. Project display and presentation at Engineering Design Day.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $75
Other Fee: This course is pending a course fee review from ABOR and the fee is subject to change if approved.
Course Components: Lecture Required
Co-convened with: AME 522
Course typically offered:
Main Campus: Spring

Enrollment requirement: Adv Stdg: Engineering. AME 420. Prerequisite or concurrent enrollment in AME 313.

AME 423: Aeroelasticity (3 units)
Description: This course is designed to teach students interested in flight mechanics the basic principles of modern aeroelasticity. A review of structural dynamics includes mechanical vibrations, modal representations, and transient response. Quasi-steady and unsteady aerodynamics of pitching and plunging airfoils and wings are discussed. Presentation of steady and dynamic aeroelastic phenomena of divergence, aileron reversal, flutter, and airload redistribution. Approximate solution methods are stressed, followed by discussions of aeroelastic tailoring and aeroelastic analysis software.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: AME 523
Course typically offered:
Main Campus: Fall

Enrollment requirement: Adv Stdg: Engineering. (AME 320 or AME 331) and AME 324B.

AME 425: Aerospace Propulsion (3 units)
Description: Basic laws; application to turbojets, ramjets, fan-jets, turbo props and rockets; space flight.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Enrollment requirement: AME 230 and AME 323 and AME 331. Adv Stdg: Engineering.

AME 426: Rocket Propulsion (3 units)
Description: This course introduces the fundamental concepts involved in getting into, around, and out of space, the means available to accomplish such tasks, and the conceptual level of rocket design. The course covers different types of propulsion systems, their basic operation, performance, and applicability. These include liquid rocket engines, hybrid rocket motors, solid rocket motors, nuclear propulsion, electric propulsion systems and advanced propulsion concepts required for interstellar flight.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: AME 230 and AME 323 and Advanced Standing: Engineering.

AME 427: Stability and Control of Aerospace Vehicles (3 units)
Description: Stability of aircraft and spacecraft; equations of motion; aerodynamic forces and moments; static stability; computer simulations; introduction to dynamic stability and feedback control.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Enrollment requirement: AME 320 and AME 321. Adv Stdg: Engineering.

AME 429: Interplanetary Mission Design (3 units)
Description: Exploration of methods related to the design and construction of trajectories for interplanetary missions, including a review of the two-body problem. Hyperbolic orbit geometry, C3 energy, Lambert's problem, sphere of influence and patched conics, launch windows, Earth departure and planetary arrival, trajectory correction maneuvers, gravity assists, three-body and lunar transfers. The main focus is on ballistic trajectory designs, including case studies of Mars Odyssey, Voyager, Galileo, Cassini, Messenger, New Horizons, Genesis, and Grail.Note that the difference of the student workload between the undergraduate and graduate versions consists of more advanced homework assignments as well as requiring the use of optimization algorithms for design projects and work in the advanced topics of three-body and lunar transfers for the graduate students. The final design project will be a group project for undergraduate students and an individual project for graduate students. Both undergraduate and graduate students will be required to learn basic aspects of the AGI Satellite Tool Kit (STK) software package and complete a series of lab assignments using both Matlab and STK.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: AME 529
Course typically offered:
Main Campus: Spring

Enrollment requirement: Adv Stdg: Engineering. AME 457.

AME 430: Intermediate Thermodynamics (3 units)
Description: Power systems; non-reacting and reacting mixtures; psychometrics; gas dynamics.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Enrollment requirement: AME 230 and Adv Stdg: Engineering

AME 431: Numerical Methods in Fluid Mechanics and Heat Transfer (3 units)
Description: Development of numerical techniques for the solution of ordinary and partial differential equations that arise in heat transfer and fluid mechanics; classification of equations, methods of solutions, examples.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: AME 531
Course typically offered:
Main Campus: Spring

Enrollment requirement: AME 302 and AME 331 and Adv Stdg: Engineering.

AME 432: Heat Transfer (3 units)
Description: Study of conduction, convection and radiation heat transfer, with applications to engineering problems.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Enrollment requirement: AME 230 and AME 331 and AME 302. Adv Std: Engineering.

AME 433: Intermediate Fluid Mechanics (3 units)
Description: Basic equations governing fluid motion. Fundamental solutions to Navier Stokes equations, principles of lubrication theory, elementary potential flow theory, turbulence, boundary layers, separation and drag, one-dimensional compressible flow, shock waves, measurement techniques.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: AME 331 and Adv Stdg: Engineering.

AME 434: Internal Combustion Engines (3 units)
Description: The course overviews modern methods in the design and analysis of the performance of internal combustion engines as well as future directions for the evolution of these engines. The course lays out and presents the first principles of thermodynamics, heat transfer, mass transfer and fluid mechanics as they relate to the internal combustion engine both in theory and in practice. The course also covers material on thermodynamic modeling, intake and exhaust flow, combustion analysis, alternative fuels, emissions, and instrumentation and control systems. A fully instrumented internal combustion engine test station is integrated into the class through a special laboratory session at appropriate times in the semester. This is designed as a technical elective course aimed at mechanical engineering seniors wishing to gain an understanding of the fundamentals of the internal combustion engine.
Grading basis: Regular Grades
Career: Undergraduate
Other Fee: This course is pending a course fee review from ABOR and the fee is subject to change if approved.
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: Adv Stdg: Engineering. AME 230 and AME 432.

AME 442A: HVAC System Design (3 units)
Description: Analysis and design of air conditioning systems for commercial and industrial buildings, including equipment and component selection. Energy-efficient concepts will be emphasized.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: NEE 442
Co-convened with: AME 542
Course typically offered:
Main Campus: Spring

Enrollment requirement: AME 230 and AME 331. Adv Stdg: Engineering.
Student Engagement Activity: Discovery
Student Engagement Competency: Innovation and Creativity

AME 442B: Advanced HVAC System Analysis and Design (3 units)
Description: Course exposes students to considerations, options and evaluation scenarios facing the practicing engineer related to annual energy consumption and sustainability in operating buildings. A recently constructed building on campus, ENR2, will be modeled and then compared to actual metered energy use. Students will use basic and advanced commercial tools for analysis of annual energy consumption of built space including building load, engineered systems and utility rate modeling and will evaluate options in envelope, building systems and source equipment selection using basic cost metrics and life cycle analysis. Building rating, performance and certification programs will be discussed. Advanced psychrometric and thermodynamic processes including multi-stage adiabatic cooling, absorption cooling, desiccant dehumidification and cooling, hydronic economizers and combined heat and power together with recent trends in HVAC including chilled beam technology will be explored.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Field trip: Class to tour the ENR2 building on campus. Tour is scheduled to occur during normal class hours subject to other scheduled building use and at the convenience of building users/occupants. No special equipment and normal student apparel is anticipated.
Enrollment requirement: Adv Stdg: Engineering. AME 442A

AME 444: Applied Thermodynamics (3 units)
Description: This course is envisioned for interested seniors and graduate students (and interested working engineers) as a means to round out their understanding of the application of the sophisticated thermodynamic principles of availability and entropy generation minimization to systems of practical and commercial importance, including cryogenic refrigerators and liquifiers.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: AME 544
Course typically offered:
Main Campus: Fall

Enrollment requirement: AME 230 and AME 331. Adv Stdg: Engineering.

AME 445: Renewable Energy Systems (3 units)
Description: Solar radiation intensity and location; basic concepts of solar thermal and photovoltaic processes; solarcollectors; economic system design for electric power and water heating, active and passive building heating and cooling,industrial processes. Wind energy fundamentals. Aerodynamic theory and economics of wind turbines. Graduate-level requirements include an in-depth research paper.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ECE 445, NEE 445
Co-convened with: AME 545
Course typically offered:
Main Campus: Fall

Enrollment requirement: AME 230 and AME 331. Adv Stdg: Engineering.

AME 446: Fuel Cell Fundamentals and Design (3 units)
Description: This course is aimed at providing the next generation of multi-disciplinary engineers with a background in clean energy that is based on hydrogen fuel and fuel cell science and technologies. The lectures are designed to pique students' interest in research and applying fuel cell power sources for various applications of electronic devices, aerospace and military missions, and distributed power generation.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $36
Course Components: Lecture Required
Co-convened with: AME 546
Course typically offered:
Main Campus: Fall

Enrollment requirement: AME 230 and AME 331. Adv Stdg: Engineering.

AME 451: Vehicle Dynamics (3 units)
Description: This course is designed to introduce undergraduate students to theories and principles of vehicle dynamics. Topics include behavior of tires, vehicle ride analysis, suspension system analysis, steering system design, cornering stability analysis, driving analysis, and braking analysis.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Summer

Enrollment requirement: AME 250 and Adv Stdg: Engineering.

AME 452: Planar Multibody Dynamics with Applications (3 units)
Description: Kinematic and dynamic analysis of mechanical systems in planar motion, numerical methods and use of computer programs in analysis.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: AME 552
Course typically offered:
Main Campus: Fall

Enrollment requirement: AME 250 and AME 302 and AME 352. Adv Stdg: Engineering.

AME 454: Spacecraft Attitude Dynamics and Control (3 units)
Description: Spacecraft attitude description on SO(3) using rotation matrices and attitude parameterizations; Wahba's problem and static attitude determination; rigid body dynamics, torque-free attitude dynamics and stability of rigid body motion; gravity gradient torque and stabilization, nutation damping, reaction control thrusters, and momentum exchange actuation; nonlinear regulator and attitude tracking using feedback control.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: AME 554
Course typically offered:
Main Campus: Spring

Enrollment requirement: Adv Stdg: Engineering. AME 302.

AME 455: Control System Design (3 units)
Description: Mathematical modeling of dynamical systems, hardware and software issues; computer simulations; classical control methods including transient response, steady-state errors, bode diagrams, root locus and design of closed loop control systems; introduction to state feedback design and digital control.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $50
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: AME 250 and AME 301. Prerequisite or concurrent enrollment in AME 300. Adv Stdg: Engineering.

AME 457: Orbital Mechanics and Space Flight (3 units)
Description: Students will acquire a foundation in orbital mechanics with comprehensive study of Earth orbits and some analysis of interplanetary trajectories. Mechanics, time-displacement, and classical coordinate systems will be emphasized. Real satellites and spacecraft will be the basis for many problems.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with:
Course typically offered:
Main Campus: Spring

Enrollment requirement: AME 250 and MATH 223. Adv Stdg: Engineering

AME 460: Mechanical Vibrations (3 units)
Description: Free and forced vibrations of simple mechanical systems; effects of damping; introduction to multidegree of freedom systems.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Enrollment requirement: AME 250 and MATH 254. Adv Stdg: Engineering

AME 462: Composite Materials (3 units)
Description: Classification and characteristics of composite materials; mechanical behavior of composite materials, micro- and macro-mechanical behavior of laminae; mechanical behavior of laminates; mechanical behavior of short fiber composites.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $50
Course Components: Lecture Required
Co-convened with: AME 562
Course typically offered:
Main Campus: Spring

Enrollment requirement: AME 302, AME 324A, (AME 324B or AME 324C).Adv Stdg: Engineering.

AME 463: Finite Element Analysis with ANSYS (3 units)
Description: Fundamentals of finite element analysis, model generation, solution procedure, post processing in ANSYS for problems from various disciplines such as structural thermal or fluids.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: AME 426
Course typically offered:
Main Campus: Spring

Enrollment requirement: AME 301 and AME 302 and (AME 324A or CE 215). Adv Stdg: Engineering

AME 466: Biomechanical Engineering (3 units)
Description: Subjects selected yearly from: biosolids, biofluids, biotransport; physiological systems; bioheat transfer.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $11
Course Components: Lecture Required
Equivalent to: BME 466
Also offered as: BME 466
Co-convened with: BME 566
Course typically offered:
Main Campus: Spring

Home department: Biomedical Engineering
Enrollment requirement: Adv Stdg: Engineering.

AME 472: Reliability Engineering (3 units)
Description: Times-to-failure distributions, including the normal, lognormal, exponential, Weibull, Rayleigh, binomial, Poisson; mean time between failures (MTBF); failure-rate and reliability determination for early, useful and wear-out lives; equipment reliability prediction; series, parallel, standby reliability; multimode function and logic; spare parts provisioning; reliability growth; reliability allocation; failure modes, effects, and criticality analyses; fault tree analysis.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: AME 572
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Prerequisites: SIE 305 (for SIE majors) or knowledge of basic probability and statistics (for non-SIE majors).
Enrollment requirement: Adv Stdg: Engineering.

AME 480: Introduction to Nuclear Engineering (3 units)
Description: Introductory aspects of nuclear engineering, including the nuclear physics of nuclear reactors, interaction of radiation with matter, nuclear reactor theory, reactor heat removal, radiation protection, and radiation shielding.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: AME 580
Course typically offered:
Main Campus: Spring

Enrollment requirement: Senior status required. Adv Stdg: Engineering

AME 483: Micro Biomechanics (3 units)
Description: Thermodynamics, mechanics, and structures of biomolecules (e.g., proteins and DNA) and cells. Deformation mechanisms and theories for both flexible and semi-rigid chains, and the applications in biomolecules and cells. Experimental micro biomechanics techniques for both biomolecules and cells.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: BME 483
Also offered as: BME 483
Co-convened with: AME 583
Course typically offered:
Main Campus: Spring

Enrollment requirement: AME 230 (or ABE 284 for BME majors only) and MATH 223 and (AME 324A or CE 215).

AME 487: Design of Mechatronic Systems (3 units)
Description: This is a hands-on laboratory course presents the field of embedded systems through a series of lectures and independent-study hands-on modules. Students work individually or in teams of two and complete weekly mini-projects aimed at providing a working knowledge of micro-controller programming, basic digital and analog circuits, and design of discrete-time controllers. Each of the mini-projects is implemented and tested on an electronic breadboard. The course culminates with an open-ended design project integrating the skills developed though the mini-modules. Students in the graduate section of the course are required to demonstrate an ability to design and implement closed-loop control as part of their design project.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $50
Course Components: Laboratory May Be Offered
Lecture Required
Co-convened with: AME 587
Course typically offered:
Main Campus: Spring

Enrollment requirement: Adv Stdg: Engineering.

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

AME 488: Micro and Nano Transducer Physics and Design (3 units)
Description: Principles, design, and performance of micro and nano transducers. Designing MEMS to be produced with both foundry and nonfoundry processes. Applications of unique properties of micro and nano transducers for biological and engineering problems. Associated signal processing requirements for these applications.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ABE 488
Also offered as: BE 488
Co-convened with: AME 588
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Recommended: AME/ABE 489/589.
Enrollment requirement: Adv. Stdg: Engineering, or (Plant Sciences, Environmental Science, or Environmental and Resource Economics major with Junior or Senior status). (ECE 207 or ABE 447) and AME 250.

AME 489A: Fabrication Techniques for Micro- and Nanodevices (3 units)
Description: This course tackles the techniques for the design, fabrication, and testing of traditional microelectromechanical systems (MEMS) and nanodevices. Each student will be required to participate in weekly laboratory sessions, to keep a laboratory notebook, and to submit a project report (25% Honors final grade;15% Undergraduate final grade) focusing on the design, fabrication, and testing of a MEMS device. Honors students receive additional homework assignments typically involving derivation or proof of a theory presented in class. Additionally, Honors students are asked to complete an independent MEMS/NEMS design, while undergraduates can use an existing device design. Grading differences are reflected in the syllabus.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $100
Course Components: Laboratory May Be Offered
Lecture Required
Equivalent to: ABE 489A
Also offered as: BE 489A
Co-convened with: AME 589A
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Completion of Laboratory Chemical Safety Course (see http://risk.arizona.edu/training/index.shtml).
Enrollment requirement: Adv. Stdg: Engineering, or (Plant Sciences, Environmental Science, or Environmental and Resource Economics major with Junior or Senior status). ECE 207 or ABE 447.

AME 492: Directed Research (1 - 6 units)
Description: Individual or small group research under the direction of faculty.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated for a maximum of 12 units.
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Adv Stdg: Engineering.
Student Engagement Activity: Discovery
Student Engagement Competency: Innovation and Creativity

AME 493: Internship (1 - 3 units)
Description: Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

Enrollment requirement: Adv Stdg: Engineering.
Student Engagement Activity: Professional Development
Student Engagement Competency: Professionalism

AME 495S: Senior Colloquium (1 unit)
Description: Course provides transition between the academic experience and the world of work. Lectures on interviewing, resume writing, becoming a registered PE, financial planning, and engineering ethics are presented. Recent graduates are invited to share their experiences.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Colloquium Required
Course typically offered:
Main Campus: Fall

Enrollment requirement: Adv Stdg: Engineering.

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

AME 498H: Honors Thesis (3 units)
Description: An honors thesis is required of all the students graduating with honors. Students ordinarily sign up for this course as a two-semester sequence. The first semester the student performs research under the supervision of a faculty member; the second semester the student writes an honors thesis.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated for a maximum of 9 units.
Course typically offered:
Main Campus: Fall, Spring, Summer

Enrollment requirement: Adv Stdg: Engineering. Honors active.
Honors Course: Honors Course
Honors Course: Honors Course
Writing Emphasis: Writing Emphasis Course

AME 499: Independent Study (1 - 3 units)
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

Enrollment requirement: Adv Stdg: Engineering.

AME 499H: Honors Independent Study (1 - 3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

Enrollment requirement: Adv Stdg: Engineering. Honors active.
Honors Course: Honors Course
Honors Course: Honors Course

AME 500A: Advanced Engineering Analysis (3 units)
Description: Vector calculus, linear algebra; ordinary differential equations, calculus of variations.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Undergraduate mathematics equivalent to AME 301.

AME 500B: Advanced Engineering Analysis (3 units)
Description: Complex variables, partial differential equations, eigenfunction expansions and transform methods.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

AME 520: Aircraft Conceptual Design (3 units)
Description: Phases of design; take-off weight, Breguet method; sizing to stall speed requirements; sizing to landing distance; sizing to climb requirements; maneuvering; cruise requirements; landing distance sizing; summary of matching results; selection of overall configuration; aircraft of unusual configurations. Students form teams to work on industry-sponsored projects. Preliminary design review by end of the semester. Students develop conceptual designs for aircraft with specified performances and figures of merit.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: AME 420
Course typically offered:
Main Campus: Fall

AME 521: Spacecraft Optimal Estimation (3 units)
Description: Theory of batch and sequential (Kalman) filtering as applied to the optimal estimation of spacecraft orbit and attitude, including a review of necessary concepts of probability and statistics. Information filters, smoothing, consider covariance analysis, and introduction to nonlinear filtering. Course work includes a term project that allows students to apply theory to an actual spacecraft orbit determination problem using real ranging data.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: AME 500A, familiarity with Matlab programming.

AME 522: Aerospace Engineering Design (3 units)
Description: Students work in teams on industry-sponsored design projects. Aerospace vehicle engineering design process. Determination of load factors, flight envelops, aerodynamic and inertial loads. Material selection. Structural analysis of wing, fuselage, and landing gear. Structure failure criteria. Critical review of senior design project at the middle of the semester. Project display and presentation at Engineering Design Day. Graduate students create detailed design by utilizing wind tunnel experiments, FEM, and CFD software.
Grading basis: Regular Grades
Career: Graduate
Flat Fee: $75
Other Fee: This course is pending a course fee review from ABOR and the fee is subject to change if approved.
Course Components: Lecture Required
Co-convened with: AME 422
Course typically offered:
Main Campus: Spring

AME 523: Aeroelasticity (3 units)
Description: This course is designed to teach students interested in flight mechanics the basic principles of modern aeroelasticity. A review of structural dynamics includes mechanical vibrations, modal representations, and transient response. Quasi-steady and unsteady aerodynamics of pitching and plunging airfoils and wings are discussed. Presentation of steady and dynamic aeroelastic phenomena of divergence, aileron reversal, flutter, and airload redistribution. Approximate solution methods are stressed, followed by discussions of aeroelastic tailoring and aeroelastic analysis software.Graduate students are assigned term projects to investigate divergence and flutter characteristics of the swept back or swept forward wing based on p-method and the transient fluid-structure analysis with the help of ANSYS/FLUENT software. Undergraduate students will analyze divergence and flutter characteristics of straight trapezoidal wings using low-order p-k method and quasi-steady thin airfoil theory.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: AME 423
Course typically offered:
Main Campus: Fall

AME 529: Interplanetary Mission Design (3 units)
Description: Exploration of methods related to the design and construction of trajectories for interplanetary missions, including a review of the two-body problem. Hyperbolic orbit geometry, C3 energy, Lambert's problem, sphere of influence and patched conics, launch windows, Earth departure and planetary arrival, trajectory correction maneuvers, gravity assists, three-body and lunar transfers. The main focus is on ballistic trajectory designs, including case studies of Mars Odyssey, Voyager, Galileo, Cassini, Messenger, New Horizons, Genesis, and Grail.Note that the difference of the student workload between the undergraduate and graduate versions consists of more advanced homework assignments as well as requiring the use of optimization algorithms for design projects and work in the advanced topics of three-body and lunar transfers for the graduate students. The final design project will be a group project for undergraduate students and an individual project for graduate students. Both undergraduate and graduate students will be required to learn basic aspects of the AGI Satellite Tool Kit (STK) software package and complete a series of lab assignments using both Matlab and STK.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: AME 429
Course typically offered:
Main Campus: Spring

AME 530: Advanced Thermodynamics (3 units)
Description: Reversible and irreversible macroscopic thermodynamics; selected engineering applications.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: AME 230, AME 331.

AME 531: Numerical Methods in Fluid Mechanics and Heat Transfer (3 units)
Description: Development of numerical techniques for the solution of ordinary and partial differential equations that arise in heat transfer and fluid mechanics; classification of equations, methods of solutions, examples. Graduate-level requirements include three additional projects.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: AME 431
Course typically offered:
Main Campus: Spring

AME 532: Convective Transport Phenomena (3 units)
Description: Convective energy, mass and momentum transfer; internal and external flow; exact, approximate and numerical solutions; application to current problems.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: AME 432, AME 500A, computer programming ability.

AME 533: Conduction and Radiative Heat Transfer (3 units)
Description: Conduction of heat; steady, transient, moving heat source, phase change, hyperbolic conduction, nonlinear problems and composite media; separation of variables. Laplace transform, integral transform, and Green's function methods. Fundamentals of radiative heat transfer; radiative properties of materials; gray-body and spectral exchange between surfaces; participating media; radiation combined with conduction and convection.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: AME 432.

AME 535: Boundary Layers (3 units)
Description: Boundary Layer Equations, basic solutions, turbulent flows, compressibility effects, 3D boundary layers.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: AME 500A, AME 500B, AME 536A, AME 536B.

AME 536A: Fundamentals of Fluid Mechanics (3 units)
Description: Fundamental equations of motions; surface tension; kinematics of vorticity; integral solutions; irrotational flows; simple viscous flows.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Concurrent registration, AME 500A.

AME 536B: Fundamentals of Fluid Mechanics (3 units)
Description: Small-disturbance inviscid theory; low Reynolds number flow; vorticity dynamics; boundary layers.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Concurrent registration, AME 500B.

AME 536C: Compressible Fluid Dynamics (3 units)
Description: Governing equations for compressible flows, shock and expansion waves, linearized flow, hypersonic flow, viscous flow, high temperature gas dynamics.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: AME 500A, AME 536A. Concurrent registration, AME 500B.

AME 538: Nature of Turbulent Shear Flow (3 units)
Description: Physical phenomena in turbulent shear flows; experimental techniques; observations and physical consequences; prediction methods; recent advances.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: MSE 538
Course typically offered:
Main Campus: Fall

Recommendations and additional information: AME 500B, AME 536A, AME 536B.

AME 542A: HVAC System Design (3 units)
Description: Analysis and design of air conditioning systems for commercial and industrial buildings, including equipment and component selection. Energy-efficient concepts will be emphasized. Graduate-level requirements include a comprehensive design project.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: NEE 542
Co-convened with: AME 442
Course typically offered:
Main Campus: Spring

AME 544: Applied Thermodynamics (3 units)
Description: This course is envisioned for interested seniors and graduate students (and interested working engineers) as a means to round out their understanding of the application of the sophisticated thermodynamic principles of availability and entropy generation minimization to systems of practical and commercial importance, including cryogenic refrigerators and liquifiers. Graduate-level requirements include material taught, such as "constructal theory" and entropy generation minimization, that are generally too sophisticated to use as undergraduate material.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: AME 444
Course typically offered:
Main Campus: Fall

AME 545: Renewable Energy Systems (3 units)
Description: Solar radiation intensity and location; basic concepts of solar thermal and photovoltaic processes; solarcollectors; economic system design for electric power and water heating, active and passive building heating and cooling,industrial processes. Wind energy fundamentals. Aerodynamic theory and economics of wind turbines. Graduate-level requirements include an in-depth research paper. Graduate-level requirements include an in-depth research paper.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: NEE 545
Co-convened with: AME 445
Course typically offered:
Main Campus: Spring

AME 546: Fuel Cell Fundamentals and Design (3 units)
Description: This course is aimed at providing the next generation of multi-disciplinary engineers with a background in clean energy that is based on hydrogen fuel and fuel cell science and technologies. The lectures are designed to pique students¿ interest in research and applying fuel cell power sources for various applications of electronic devices, aerospace and military missions, and distributed power generation. Graduate-level requirements include extra homework problems and projects.
Grading basis: Regular Grades
Career: Graduate
Flat Fee: $36
Course Components: Lecture Required
Co-convened with: AME 446
Course typically offered:
Main Campus: Fall

AME 550: Advanced Dynamics (3 units)
Description: Lagrange's equations, rigid body and multibody dynamics; Euler's equations, vibrations theory.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: AME 250, knowledge of differential equations.

AME 552: Planar Multibody Dynamics with Applications (3 units)
Description: Kinematic and dynamic analysis of mechanical systems in planar motion, numerical methods and use of computer programs in analysis. Graduate-level requirements include an additional project and extra questions on exams.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: AME 452
Course typically offered:
Main Campus: Fall

AME 553: Computational Multibody Dynamics (3 units)
Description: Computational methods in spatial multibody dynamics; Euler parameters; automatic generation and numerical methods in solving equations of motion; application in vehicle dynamics, spacecraft, and robotics.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Knowledge of kinematics, dynamics, and numerical methods.

AME 554: Spacecraft Attitude Dynamics and Control (3 units)
Description: Spacecraft attitude description on SO(3) using rotation matrices and attitude parameterizations; Wahba's problem and static attitude determination; rigid body dynamics, torque-free attitude dynamics and stability of rigid body motion; gravity gradient torque and stabilization, nutation damping, reaction control thrusters, and momentum exchange actuation; nonlinear regulator and attitude tracking using feedback control. Graduate-level requirements include an individual research project (versus a group project for undergraduates), as well as additional topics and more advanced homework assignments.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: AME 454
Course typically offered:
Main Campus: Spring

AME 555: Introduction to System Identification Methods (3 units)
Description: This course provides an introduction to the field of system identification, which involves the use data from experiments to obtain static and dynamic models useful for simulation, prediction, and control design. Topics include identification of non-parametric models including empirical transfer function and impulse response identification, as well as parametric model identification through predictor error methods. Discussion on selection of proper input data and model validation is also included. The courses makes significant use of MATLAB's System Identification Toolbox.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Field trip: None

AME 557: Orbital Mechanics and Space Flight (3 units)
Description: Students will acquire a foundation in orbital mechanics with comprehensive study of Earth orbits and some analysis of interplanetary trajectories. Mechanics, time-displacement, and classical coordinate systems will be emphasized. Real satellites and spacecraft will be the basis for many problems. Individual design project (versus group project for undergraduates), as well as additional topics and more advanced homework assignments.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: AME 457
Course typically offered:
Main Campus: Fall

AME 558: Introduction to Advanced Control Theory (3 units)
Description: State space representation of dynamical systems; topics include controllability, observability, stability, full state feedback, pole placement, optimal regulators, phase portrait method, and Lyapunov stability.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: AME 455.

AME 559: Advanced Astrodynamics (3 units)
Description: Modeling of gravitating dynamical systems within Newtonian, Lagrangian, and Hamiltonian frameworks with application to spacecraft motion in non-Keplerian and strongly perturbed environments. n-body problem, classical integrals of motion, Sundman's inequality, and central configurations; two-body and restricted two-body problems, classical, equinoctial, Delaunay, and Poincare orbital elements, universal variables; perturbation methods, Lagrange's and Gauss's equations, method of averaging, canonical transformations and perturbation theory; gravitational potential field models; oblateness, 3rd body, and SRP effects; two body relative motion, Clohessy-Wiltshire-Hill and Tschauner Hempel-Lawden equations, state transition matrices, and orbital element difference description; restricted and Hill-restricted three-body and four-body problems, Jacobi integral, equilibria, periodic solutions, local stability, invariant manifolds, and chaotic trajectories; generalization of n-body problem to rigid mass distributions, full 2-body problem, coupled orbital and attitude dynamics in central gravity.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Prerequisite: AME 557 if no undergraduate orbital mechanics class and/or a LPL/Astronomy major.

AME 560: Advanced Vibration (3 units)
Description: Analytical treatment of the vibration of continuous and distributed parameter systems such as strings, rods, and beams; finite-element and numerical methods in vibration and modal analysis; frequency domain analysis; nonlinear effects and stochastic methods.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: AME 460 or similar introductory vibrations course; AME 463 or similar finite element course desired; AME 550.

AME 561: Finite Element Methods (3 units)
Description: This course will introduce the student to the finite element method to solve boundary value problems in structural mechanics (statics and dynamics), heat transfer, and acoustics. Derivation of elements, weighted-residual (Galerkin) methods, Rayleigh Ritz method, convergence will be studied. This course will have a strong theoretical component but will also have practical sessions during which a commercial finite element software will be used. A final project will help students synthesize the knowledge acquired during the course.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: EM 561
Course typically offered:
Main Campus: Spring

Recommendations and additional information: AME 500A. Fundamental notions in solid mechanics and heat transfer are preferable but not required.

AME 562: Composite Materials (3 units)
Description: Classification and characteristics of composite materials; mechanical behavior of composite materials, micro- and macro-mechanical behavior of laminae; mechanical behavior of laminates; mechanical behavior of short fiber composites. Graduate-level requirements include an additional project on composite materials.
Grading basis: Regular Grades
Career: Graduate
Flat Fee: $50
Course Components: Lecture Required
Co-convened with: AME 462
Course typically offered:
Main Campus: Spring

AME 563: Advanced Finite Element Analysis (3 units)
Description: [Taught alternate years beginning Spring 2011]. Finite element methods, including material nonlinearity (elastic, plastic, viscoelastic); geometric nonlinearity (finite deformations), numerical solution methods, and nonlinear programs.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: AME 561.

AME 564A: Mechanics of Deformable Solids (3 units)
Description: Mathematical preliminaries, motion and deformation, balance laws of mechanics, state of stress and equations of motion, constitutive equations, uniqueness, Betti-Rayleigh reciprocity theorem, applications from classical elasticity.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

AME 564B: Mechanics of Deformable Solids (3 units)
Description: Review of fundamental principles of mechanics of deformable bodies, plasticity, thermoelasticity, viscoelasticity and creep.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: AME 564A.

AME 565: Design Optimization (3 units)
Description: [Taught alternate years beginning Fall 2011] This course aims at providing basic knowledge in recent design optimization methods and tools. Typical examples of design optimization problems involve the minimization of structural weight and cost while satisfying performance constraints. Emphasis will be on applied design optimization and its application in the context of simulation-based design. Techniques ranging from optimal sizing, shape, and topology optimization to design of experiments and response surfaces will be presented.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Prerequisite or concurrent registration, finite element course (undergraduate or graduate).

AME 566: Biomechanical Engineering (3 units)
Description: Subjects selected yearly from: biosolids, biofluids, biotransport; physiological systems; bioheat transfer. Graduate-level requirements include a project and additional reading assignments.
Grading basis: Regular Grades
Career: Graduate
Flat Fee: $11
Course Components: Lecture Required
Equivalent to: BME 566
Also offered as: BME 566
Co-convened with:
Course typically offered:
Main Campus: Spring

Home department: Biomedical Engineering

AME 567: Computer Graphics and CAD (3 units)
Description: Computer graphics programs and packages, 2D and 3D object transformations, homogeneous coordinates, parallel and perspective projections, clipping and view volumes, spline curves and surfaces, solid models, hidden line and surface removal, lighting and shading, graphical user interfaces, graphics file formats, Animation, implementations using OpenGL. Graduate-level requirements include a more extensive and in-depth project, have to do additional assignment or additional question on the exam, be graded on a separate curve from the ECE467 students (receiving undergraduate credit), if there is a need to curve the student scores at the semesters end.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: AME 567
Also offered as: ECE 567
Course typically offered:
Main Campus: Fall

Home department: Electrical & Computer Engr

AME 568: Probabilistic Design (3 units)
Description: Theoretical and computational aspects for propagation of uncertainties through a model. Methods for problems with traditional random variables and random fields will be presented. These fundamental aspects will be complemented by the description of engineering applications.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Any one of: AME 463, AME 561, AME 563, CE 402, or CE 502.

AME 572: Reliability Engineering (3 units)
Description: Times-to-failure distributions, including the normal, lognormal, exponential, Weibull, Rayleigh, binomial, Poisson; mean time between failures (MTBF); failure-rate and reliability determination for early, useful and wear-out lives; equipment reliability prediction; series, parallel, standby reliability; multimode function and logic; spare parts provisioning; reliability growth; reliability allocation; failure modes, effects, and criticality analyses; fault tree analysis. Graduate-level requirements include a special report of 30 pages on a specific reliability engineering topic.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: AME 472
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Prerequisites: SIE 305 (for SIE majors) or knowledge of basic probability and statistics (for non-SIE majors).

AME 580: Introduction to Nuclear Engineering (3 units)
Description: Introductory aspects of nuclear engineering, including the nuclear physics of nuclear reactors, interaction of radiation with matter, nuclear reactor theory, reactor heat removal, radiation protection, and radiation shielding. Graduate-level requirements include additional lesson on reactor physics called Transport Theory--high-level mathematical concept; students will be tested on the theory.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: AME 480
Course typically offered:
Main Campus: Spring

AME 583: Micro Biomechanics (3 units)
Description: Thermodynamics, mechanics, and structures of biomolecules (e.g., proteins and DNA) and cells. Deformation mechanisms and theories for both flexible and semi-rigid chains, and the applications in biomolecules and cells. Experimental micro biomechanics techniques for both biomolecules and cells. Graduate-level requirements include comprehensively review one of the mainstream experimental techniques in micro biomechanics and submit a final report.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: BME 583
Also offered as: BME 583
Co-convened with: AME 483
Course typically offered:
Main Campus: Spring

AME 585: Nanoscale Heat Transfer (3 units)
Description: Targeted to students with a traditional engineering background, this course will provide the fundamental knowledge on the thermal energy transport across all length and time scales, while showing how these fundamental understanding can be employed to develop advanced energy-related materials or improve the thermal management of electronic devices. Topics include the energy levels, the statistical behavior and internal energy, energy transport in the forms of waves and particles, scattering and heat generation processes, Boltzmann equation and derivation of classical laws, deviation from classical laws at nanoscale and their appropriate descriptions. The state-of-the-art development of nanoscale heat transfer will be reviewed, including the studies on various micro- to nano-structures (e.g. nanowire, superlattice, carbon nanotube, graphene), nanostructured bulk materials (e.g. thermoelectric nanocomposites), and nanoelectronics. The transport of different energy carriers (electrons, phonons, molecules, and photons) will be treated in parallel to show the similarities between different processes.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Students should be familiar with MATLAB (numerical integration, simple programming) and have taken AME 500A and 500B (Advanced Engineering Analysis) or equivalent math courses.

AME 586: Microfluidics (3 units)
Description: Fundamentals of micro scale fluid mechanics: size effects; fabrication and diagnostic techniques for micro fluidic systems; pressure-driven gas flows in micro systems; electro kinetically-driven liquid flows in micro systems; micro polar liquid flows.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

AME 587: Design of Mechatronic Systems (3 units)
Description: This is a hands-on laboratory course presents the field of embedded systems through a series of lectures and independent-study hands-on modules. Students work individually or in teams of two and complete weekly mini-projects aimed at providing a working knowledge of micro-controller programming, basic digital and analog circuits, and design of discrete-time controllers. Each of the mini-projects is implemented and tested on an electronic breadboard. The course culminates with an open-ended design project integrating the skills developed though the mini-modules. Students in the graduate section of the course are required to demonstrate an ability to design and implement closed-loop control as part of their design project.
Grading basis: Regular Grades
Career: Graduate
Flat Fee: $50
Course Components: Laboratory May Be Offered
Lecture Required
Co-convened with: AME 487
Course typically offered:
Main Campus: Spring

Field trip: None

AME 588: Micro and Nano Transducer Physics and Design (3 units)
Description: Principles, design, and performance of micro and nano transducers. Designing MEMS to be produced with both foundry and nonfoundry processes. Applications of unique properties of micro and nano transducers for biological and engineering problems. Associated signal processing requirements for these applications. Graduate-level requirements include review and presentation on one of the following topics: AFM, Confocal Microscopy, FTIR, NSOM, Multi-photon Microscopy, SEM, SICM, STM, TEM, Ultrasound, and XPS. Undergraduate students can choose to design and analyze a MEMS device as term project.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ABE 588
Also offered as: BE 588
Co-convened with: AME 488
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Recommended: ABE 589 or AME 589.

AME 589A: Fabrication Techniques for Micro- and Nanodevices (3 units)
Description: This course tackles the techniques for the design, fabrication, and testing of traditional microelectromechanical systems (MEMS) and nanodevices. Each student will be required to participate in weekly laboratory sessions, to keep a laboratory notebook, and to submit a project report (25% Honors final grade;15% Undergraduate final grade) focusing on the design, fabrication, and testing of a MEMS device. Honors students receive additional homework assignments typically involving derivation or proof of a theory presented in class. Additionally, Honors students are asked to complete an independent MEMS/NEMS design, while undergraduates can use an existing device design. Grading differences are reflected in the syllabus. Graduate-level requirements include additional homework assignments typically involving derivation or proof of a theory presented in class. Additionally, graduate students are asked to complete an independent MEMS/NEMS design, while undergraduates can use an existing device design. Grading differences are reflected in the syllabus.
Grading basis: Regular Grades
Career: Graduate
Flat Fee: $100
Course Components: Laboratory May Be Offered
Lecture Required
Equivalent to: ABE 589A
Also offered as: BE 589A
Co-convened with: AME 489A
Course typically offered:
Main Campus: Fall

Recommendations and additional information: ECE 207 or ABE 447. Completion of Laboratory Chemical Safety Course (see http://risk.arizona.edu/training/index.shtml).

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

AME 589B: Bio Micro/Nanotechnology Applications (3 units)
Description: This course tackles the applications of modern micro/nano devices or systems including lab-on-a-chip, DNA/protein array, drug carriers and other therapeutic systems, neuroscience applications, and food/agricultural systems. Toward this end, three different topics will be covered in this class: (1) brief overview on modern micro- and nanofabrication technologies, (2) biophysics principles for analytes and its recognition, and (3) various sensing modalities specific to these systems. Graduates participate in a journal club.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: AME 589B
Also offered as: BE 589B
Co-convened with: AME 489B
Course typically offered:
Main Campus: Spring

Home department: Biosystems Engineering

AME 596: AME Special Topics (3 units)
Description: This course is designed to provide a flexible topics course across several domains in the fields of Aerospace Engineering, and Mechanical Engineering. Selected advanced topics in Aerospace and Mechanical Engineering will be covered.
Grading basis: Regular Grades
Career: Graduate
Course Components: Seminar Required
Repeatable: Course can be repeated a maximum of 3 times.
Course typically offered:
Main Campus: Fall, Spring

Recommendations and additional information: AME 500A and 500B.

AME 599: Independent Study (1 - 6 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work. Graduate students doing independent work which cannot be classified as actual research will register for credit under course number 599, 699, or 799.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

AME 603: Boundary Element Method (3 units)
Description: Introduction to BEM, applications to Laplace equation, conduction-convection problems, transient problems, problems involving material nonlinearities, large strain problems, and design sensitivity-analyses through BEM.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

AME 606: Wave Propagation in Solids (3 units)
Description: [Usually offered every other Spring beginning 2003] Stress (acoustic wave propagation and dispersion in infinite solids and finite wave guides), application of wave propagation theory in destructive and nondestructive evaluation of materials and structures; dynamic failure behavior of materials.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: AME 606, AME 660, CE 660, EM 606, EM 660
Also offered as: CE 606, EM 606
Course typically offered:
Main Campus: Fall, Spring

Recommendations and additional information: AME 564A or AME 564B.
Home department: Civil and Architectural Engineering and Mechanics

AME 620: Advanced Computational Aerodynamics (3 units)
Description: Governing equations for computational aerodynamics and fluid dynamics techniques for solving partial differential equations, grid generation and multi-grid techniques; applications to compressible and incompressible viscous flows.
Grading basis: Regular Grades
Career: Graduate
Course Components: Laboratory May Be Offered
Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: AME 431, AME 500B, AME 536B.

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

AME 635: Hydrodynamic Stability (3 units)
Description: Introduction to linear stability theory in fluid mechanics; the Orr-Sommerfeld equation, behavior of eigen-solutions, stability limits, extensions to problems in two component systems.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: AME 500A, AME 500B, AME 536A, AME 536B.

AME 639: Aeroacoustics (3 units)
Description: Generation, propagation, and attenuation of acoustic waves. Effects of mean flow and applications of engineering importance.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: AME 536A, 500A and 500B.

AME 696G: Graduate Seminar (1 unit)
Description: The development and exchange of scholarly information.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Seminar Required
Repeatable: Course can be repeated a maximum of 6 times.
Course typically offered:
Main Campus: Fall, Spring

AME 699: Independent Study (1 - 6 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work. Graduate students doing independent work which cannot be classified as actual research will register for credit under course number 599, 699, or 799.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

AME 799: Independent Study (1 - 6 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work. Graduate students doing independent work which cannot be classified as actual research will register for credit under course number 599, 699, or 799.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

AME 900: Research (1 - 16 units)
Description: Individual research, not related to thesis or dissertation preparation, by graduate students.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

AME 908: Case Studies (3 units)
Description: Individual study of a particular case, or report thereof.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

AME 909: Master's Report (1 - 16 units)
Description: Individual study or special project or formal report thereof submitted in lieu of thesis for certain master's degrees.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

AME 910: Thesis (1 - 16 units)
Description: Research for the master's thesis (whether library research, laboratory or field observation or research, artistic creation, or thesis writing). Maximum total credit permitted varies with the major department.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

AME 920: Dissertation (1 - 9 units)
Description: Research for the doctoral dissertation (whether library research, laboratory or field observation or research, artistic creation, or dissertation writing).
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer