Mechanical Engineering is one of the broadest engineering disciplines. Mechanical engineers invent, analyze and design systems that produce power or convert energy. This encompasses such diverse applications as designing next-generation aircraft and automobiles, inventing novel methods of generating energy from renewable sources, and developing sophisticated new medical devices and systems. Mechanical engineers are in the forefront of exciting new technological fields, including nano-engineering, biomedical engineering, and energy research.

The basic fields of study for mechanical engineers include:

- Materials science, which is the study of the relationship between structure, properties, and processing of materials.
- Thermodynamics and heat transfer deal with basic concepts and applications of work, energy, and power. Applications include power generation from fossil fuels, from renewable sources (solar, wind energy) and fuel cells.
- Engineering mechanics is the study of static and dynamic effects of forces applied to rigid and flexible solid bodies.
- Fluid mechanics, the study of the forces and motions of liquids and gases. Included in this area of study are hydraulics, gas dynamics, aerodynamics, and design and application of pumps, compressors, and turbines.
- Control systems including studies of transient and steady-state response of systems to external inputs.
- Design synthesis which integrates all fields of engineering in the production of safe, practical, efficient, and economically feasible solutions to real problems.

All BSME students complete a senior-year "capstone" design project, in which a team of students defines and solves a unique, real-world engineering problem.

The curriculum leading to the Bachelor of Science in Mechanical Engineering (BSME) is designed so that graduates can work in any Mechanical Engineering field, or continue their educations at the graduate level.

BSME Program Educational Objectives:

Alumni of the Bachelor of Science in Mechanical Engineering (BSME) program should demonstrate the following traits and accomplishments within five years following graduation:

1. Graduates will achieve professional advancements or promotions with progressively higher levels of responsibility, competency, professional and ethical judgment and analysis. They will apply creative and innovative techniques to solve significant problems. They will apply team assimilation skills to successfully manage cross-disciplinary, collaborative projects that require global and multicultural perspectives.
2. Graduates will demonstrate effective written and oral communication skills in presenting, documenting and conveying their work. They will use these skills in creating and supporting new or improved designs, inventions, and intellectual property, thereby contributing to the social, economic, and environmental well-being of local and global communications.

3. Graduates will demonstrate commitment to lifelong and continuous professional development through activities such as mentoring, participating in professional societies, completing advanced degrees and achieving professional registration or other certifications.

Mechanical Engineering graduates will accomplish these objectives in the course of professional employment, entrepreneurship, military or public service and postgraduate education.

BSME Student Outcomes:

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

The Bachelor of Science in Mechanical Engineering program is accredited by the Engineering Accreditation Commission of ABET, [http://www.abet.org](http://www.abet.org).

BSME Accelerated Bachelors – Masters Degree Option

Qualified students may have the opportunity to apply a limited number of graduate course credits to the BSME degree and to the MSME degree. Students interested in this option should consult their ME advisor.

Exam-Compliant Calculator Policy

Every Mechanical Engineering (ME) student must have an exam-compliant calculator for use in those ME courses which allow calculator usage. Only those calculators which are acceptable for use in the Fundamentals of Engineering (FE) exam are considered to be exam-compliant and may be used in those Mechanical Engineering classes which allow calculator usage. Use of a calculator which is NOT exam complaint in an ME test, quiz, or exam will be considered academic misconduct. For a list of exam-compliant calculator models, see [http://ncees.org.exams.calculator/](http://ncees.org.exams.calculator/).

Aerospace Engineering Track

Students who plan to enter careers or graduate studies in aerospace, aeronautics, astronautics, or a related field may pursue the specialized track in Aerospace Engineering with the BSME program. Students in this track must complete AE 361 Introduction to Aerodynamics, in addition to two other approved aerospace engineering electives.

Students interested in the Aerospace Engineering track within the BSME program should consult their academic advisor.

Biomedical Engineering Track

Students who plan to enter careers or graduate studies in biomedical engineering may pursue the specialized track in Biomedical Engineering within the BSME program. This track may also be appropriate for students planning to pursue a career in the health sciences (medical school, dental school, or other health profession programs).

Students in the Biomedical Engineering track must complete General Biology I & II w/ labs (BL 121, 121L, 122, 122L), General Chemistry II w/ lab (CH 132, 132L) and Me 467, Introduction to Biomedical Engineering.

Students interested in the Biomedical Engineering track within the BSME program should consult their academic advisor. Students planning to apply for a health profession program should also consult with a Pre-Health Profession Advisor to identify any additional courses that may be required.
Areas Of Study

- Mechanical Engineering (BS)
- Mechanical Engineering (BS) - Aerospace Track
- Mechanical Engineering (BS) - Biomedical Engineering Track
- Mechanical Engineering (MS)
- Mechanical Engineering - Accelerated Bachelors

Courses

Engineering (EG)

**EG 101 Intro to Engineering & Design** 2 cr
A course for first time engineering students that assists with maximizing the student's potential to achieve academic success and to adjust responsibly to the individual and interpersonal challenges presented by college life. Introduction to engineering fundamentals through reading, homework assignments, laboratory investigations, guest lecturers and group discussions on the engineering profession.
Pre-requisite: (MA 113 Minimum Grade of D or MA 172 Minimum Grade of D) or (MA 125 Minimum Grade of C or MA 132 Minimum Grade of D). MA 113 and MA 125 can be taken concurrently with this course.

**EG 201 Intro to Engr & Prob Solving** 2 cr
A course for first-time transfer students that helps maximize the student's potential to achieve academic success and to address the transition from community college to four-year college. Introduction to engineering fundamentals and problem solving techniques through reading, homework assignments, laboratory investigations, guest lecturers and group discussions on the engineering profession.
Pre-requisite: MA 126 Minimum Grade of C.

**EG 220 Electrical Circuits** 3 cr
Pre-requisite: MA 126 Minimum Grade of C and PH 201 Minimum Grade of C.

**EG 231 Intro to Ethics and Economics** 3 cr
Introduction to ethics and the use of codes of ethics in developing an ethical profession. Application of engineering economic principles to engineering problems.
Pre-requisite: MA 126 Minimum Grade of C.

**EG 270 Engineering Thermodynamics** 3 cr
First and second law of thermodynamics with applications.
Pre-requisite: MA 126 Minimum Grade of C.

**EG 283 Statics** 3 cr
Use of vector algebra to analyze two and three dimensional forces, moments, and couples. Use of free body diagrams to analyze rigid bodies, beams, trusses, and frames in equilibrium. Calculation of the area and mass moments of inertia, and friction forces.
Pre-requisite: (MA 126 Minimum Grade of C and PH 201 Minimum Grade of C).

**EG 284 Dynamics** 3 cr
Kinematics and kinetics of particles and rigid bodies. Work/energy and momentum methods.
Pre-requisite: EG 283 Minimum Grade of C and MA 126 Minimum Grade of C.

**EG 290 Sp Top -** 1 TO 5 cr
Subjects of special interest in engineering. Requires permission of instructor.

**EG 315 Mechanics of Materials** 3 cr
Pre-requisite: EG 283 Minimum Grade of C and (MA 227 Minimum Grade of C and PH 201 Minimum Grade of C).

**EG 360 Fluid Mechanics** 3 cr
Study of the properties of fluids including fluid statics, kinematics; integral and differential equations of mass, momentum and energy conservation principles; dimensional analysis; flow in ducts; boundary layer flows; and compressible flow.
Pre-requisite: MA 238 Minimum Grade of D and EG 284 Minimum Grade of C.

**EG 390 Special Topics-** 1 TO 3 cr
This course covers topics of current interest in Engineering.

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**EG 450 Intro to Systems Engineering** 3 cr
This course will explore the history of systems engineering, the problems that contributed to the need for systems thinking, and the systems engineering lifecycle as defined by ISO/IEC/IEEE 15288 Systems and Software Engineering -- System Life Cycle Processes. This course will include a significant reading list and a systems engineering exercise that will run for the duration of the course.

**EG 480 Prin of Eng Mgmt and Ldrshp** 3 cr
An examination of skills, abilities, personality, attitudes, values, interests and behaviors to increase self-awareness of management and leadership competencies. Students will also examine the concept of Professional Improvement Process that integrates strategy, human resources and accountability.

**EG 490 Special Topics** 1 TO 3 cr
This course covers topics of current interest in Engineering.

**EG 494 DIS in Engineering** 1 TO 3 cr
Directed study, under the guidance of a faculty advisor of a topic from the field of Engineering not offered in a regularly scheduled course.

**EG 590 Sp Top -** 1 TO 3 cr
Subjects of special interest in engineering for engineering graduate students. Requires permission of instructor.

**ME 135 Engr Graphics and Comm** 3 cr
Graphical representation of objects, orthographic, oblique, and isometric views. Freehand lettering and sketching, computer aided graphics, presentation of graphics based on numerical data using spreadsheet, word processor and presentation software. Fee. Pre-requisite: MA 125 Minimum Grade of C. MA 125 can be taken concurrently with this course.

**ME 312 Mech Engr Thermodynamics** 3 cr
Thermodynamics power and refrigeration cycles, gas mixtures, psychometrics, and combustion. One-half hour of design. Pre-requisite: EG 270 Minimum Grade of D.

**ME 314 Machine Component Design** 3 cr
Analysis and design of machine elements to accomplish given tasks within limits of stress and size. One hour of design. Pre-requisite: EG 284 Minimum Grade of D and EG 315 Minimum Grade of D.

**ME 316 Instrumentation & Exp Method** 3 cr
Measuring system analysis and design, signal conditioning, analysis of data, statistical error analysis, communication of results. Pre-requisite: EG 220 Minimum Grade of D and (MA 238 Minimum Grade of D or MA 338 Minimum Grade of D) and (PH 202 Minimum Grade of C or PH 217 Minimum Grade of C) and ME 328 Minimum Grade of D.

**ME 317 Heat Transfer** 3 cr
Steady and transient, multi-dimensional conduction, forced and natural convection, radiation, and heat exchangers. One-half hour of design. Pre-requisite: EG 270 Minimum Grade of D and ME 328 Minimum Grade of D and (MA 238 Minimum Grade of D or MA 338 Minimum Grade of D) and (EG 360 Minimum Grade of D or CE 365 Minimum Grade of D or ME 324 Minimum Grade of D).

**ME 319 Instrumentation & Exp Method Lab** 1 cr
Laboratory component of ME 316 Instrumentation. The same grade will be given in both courses. Co-requisite: ME 316 Pre-requisite: EG 220 Minimum Grade of D and (MA 238 Minimum Grade of D or MA 338 Minimum Grade of D) and (PH 202 Minimum Grade of D or PH 217 Minimum Grade of D).

**ME 326 Materials Science** 3 cr
Mechanical, chemical, and physical properties of materials. Relationship between structure, processing, and properties engineering materials. One-half hour of design. Pre-requisite: (PH 202 Minimum Grade of C or PH 217 Minimum Grade of C) and (CH 115 Minimum Grade of C or CH 131 Minimum Grade of C) and EG 315 Minimum Grade of C.

**ME 328 ME Analysis** 4 cr
Numerical solutions of differential equations with applications to ME simulation and design. Introduction to Finite Element Analysis. One-half hour of design. Pre-requisite: MA 227 Minimum Grade of C and MA 237 Minimum Grade of C and MA 238 Minimum Grade of C.

**ME 336 Material Science Lab-W** 1 cr
Experimental study on the effect of thermal and mechanical processing on properties. Pre-requisite: ME 326 Minimum Grade of D and PH 202 Minimum Grade of C and CH 131 Minimum Grade of C and EG 315 Minimum Grade of C. ME 326 can be taken concurrently with this course.
ME 365  Design of Fluid Power Systems  3 cr
Fluid power components are studied in detail. Design of complete hydraulic systems is stressed. One hour of design. Pre-requisite: EG 284 Minimum Grade of D and EG 315 Minimum Grade of D and (EG 360 Minimum Grade of D or CE 365 Minimum Grade of D or ME 324 Minimum Grade of D) and ME 328 Minimum Grade of D.

ME 410  Principles of Eng Design-W  3 cr
In this course, students learn to apply engineering theory and methods to the design process. Topics include problem definition, concept development and evaluation, project management, materials selection, risk analysis, quality improvement and ethics in design (0-3-0).
Pre-requisite: ME 314 Minimum Grade of D and EG 231 Minimum Grade of C and ME 336 Minimum Grade of D and ME 317 Minimum Grade of D and ME 316 Minimum Grade of D and ME 336 and ME 317 can be taken concurrently with this course.

ME 411  Thermal System Design  3 cr
Thermal system design using principles of thermodynamics, fluid mechanics, heat transfer, and numerical simulation. Communication of results. Three hours of design.
Pre-requisite: ME 312 Minimum Grade of D and ME 317 Minimum Grade of D and ME 328 Minimum Grade of D and (EG 360 Minimum Grade of D or CE 365 Minimum Grade of D or ME 324 Minimum Grade of D).

ME 412  Thermal Science Laboratory  1 cr
Experimental study of thermal science principles and systems. Communication of results. Pre-requisite: ME 312 Minimum Grade of D and ME 316 Minimum Grade of D and ME 317 Minimum Grade of D and (EG 360 Minimum Grade of D or CE 365 Minimum Grade of D or ME 324 Minimum Grade of D).

ME 414  Capstone Design  1 cr
This course is considered a "Senior Capstone Course." Co-requisite: ME 416
Pre-requisite: ME 410 Minimum Grade of D.

ME 416  Capstone Design Project  2 cr
This is a team-based capstone project course. Each team is assigned a unique design problem in mechanical engineering or a closely-related field. Students must be enrolled concurrently in ME 414 - Capstone Design.
Co-requisite: ME 414
Pre-requisite: ME 410 Minimum Grade of D.

ME 417  Dynamics of Machines  3 cr
A study of the effects of external forces and moments on the motion of machines. Topics include the study of the position, velocity and acceleration of machine components during operation and the determination of forces on the connections and members. One hour of design.
Pre-requisite: EG 284 Minimum Grade of D and EG 315 Minimum Grade of D and ME 328 Minimum Grade of D.

ME 419  Computer Aided Design & Manu  3 cr
Introduction to computer aided design (CAD) and computer aided manufacturing (CAM) principles and their practical applications as fundamental elements of contemporary product design and manufacturing. This course is dual listed with an equivalent 500-level mechanical engineering course. One hour of design.
Pre-requisite: ME 135 Minimum Grade of D and ME 314 Minimum Grade of D.

ME 421  Mechanical System Design  3 cr
A study of design techniques as applied to mechanical components and systems. Computer simulation and numerical techniques. Communication of results. Three hours of design.
Pre-requisite: ME 314 Minimum Grade of D and ME 328 Minimum Grade of D.

ME 422  Gas Turbines  3 cr
Introduction to gas turbines covering thermodynamics, fluid mechanics, combustion, cycle analysis, compressors, turbines and component design. One hour of credit.
Pre-requisite: (EG 360 Minimum Grade of D or CE 365 Minimum Grade of D or ME 324 Minimum Grade of D) and ME 312 Minimum Grade of D.

ME 426  Dynamic Systems and Control  3 cr
Modeling dynamic systems. Introduction to the principles of feedback control systems. Analysis of linear systems. Pre-requisite: (MA 238 Minimum Grade of D or MA 338 Minimum Grade of D) and ME 316 Minimum Grade of D and ME 328 Minimum Grade of D.

ME 429  Controls & Instr. Lab  1 cr
Design and implementation of analog and digital feedback control of systems. Design and implementation of measurement systems, including signal conditioning, analog-to-digital and digital-to-analog conversion, statistical estimation of error, data analysis. Communication of laboratory results is emphasized.
Pre-requisite: ME 426 Minimum Grade of D. ME 426 can be taken concurrently with this course.

ME 430  Mechanism Synthesis  3 cr
Kinematic synthesis of planar linkages for function, path, and motion generation. Topics include: degrees of freedom; graphical, linear analytical, and nonlinear analytical methods; and curvature theory. This course is dual-listed with an equivalent 500-level mechanical engineering course. One hour of design.
Pre-requisite: EG 284 Minimum Grade of D and ME 328 Minimum Grade of D.

ME 431  Gas Dynamics  3 cr
Introduction to compressible fluid flow. Conservation laws, isentropic flow, adiabatic flow, flow with heat transfer, normal shock. One hour of design.
Pre-requisite: (EG 360 Minimum Grade of D or CE 365 Minimum Grade of D or ME 324 Minimum Grade of D) and ME 312 Minimum Grade of D.
<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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<th>Pre-requisites</th>
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<tbody>
<tr>
<td>ME 432</td>
<td>Advanced Thermodynamics</td>
<td>3 cr</td>
<td>Continuation of Mechanical Engineering Thermodynamics to develop a broader and deeper understanding of thermal energy transformations. One hour of design. Pre-requisite: ME 312 Minimum Grade of D.</td>
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<tr>
<td>ME 438</td>
<td>Finite Element Analysis</td>
<td>3 cr</td>
<td>Introduction to the finite element method. Engineering application to stress-strain analysis is emphasized. Other field problems are also considered. This course is dual-listed with an equivalent 500-level mechanical engineering course. Pre-requisite: ME 328 Minimum Grade of D.</td>
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</tr>
<tr>
<td>ME 439</td>
<td>Boundary Elements I</td>
<td>3 cr</td>
<td>Fundamental concepts of the boundary element method of numerically solving partial differential equations. Application to potential flow problems in heat transfer. This course is dual listed with an equivalent 500-level mechanical engineering course. Pre-requisite: ME 328 Minimum Grade of D.</td>
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</tr>
<tr>
<td>ME 441</td>
<td>Microprocessors for Mech Engr</td>
<td>3 cr</td>
<td>Basic concepts of programming and applying microprocessors to the control of mechanical systems. Assembly language programming, Memory decoding and use. Input and output circuits. Interfacing with the PIA. Pre-requisite: EG 220 Minimum Grade of D and ME 316 Minimum Grade of D.</td>
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<tr>
<td>ME 450</td>
<td>Heat Vent and Air Conditioning</td>
<td>3 cr</td>
<td>Addresses the heating and cooling of buildings. Covers related engineering sciences, cooling and heating loads, systems, and equipment. One hour of design. Pre-requisite: (EG 360 Minimum Grade of D or CE 365 Minimum Grade of D or ME 324 Minimum Grade of D) and ME 312 Minimum Grade of D and ME 317 Minimum Grade of D.</td>
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<tr>
<td>ME 451</td>
<td>Refrigeration Systems</td>
<td>3 cr</td>
<td>Study of refrigeration systems including solutions of typical engineering design problems. Concepts from fluid mechanics, thermodynamics, and heat transfer are used. One hour of design. Pre-requisite: (EG 360 Minimum Grade of D or CE 365 Minimum Grade of D or ME 324 Minimum Grade of D) and ME 312 Minimum Grade of D and ME 317 Minimum Grade of D.</td>
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<tr>
<td>ME 452</td>
<td>Combustion</td>
<td>3 cr</td>
<td>Introduction to the theory of combustion processes, chemical equilibrium, adiabatic flame temperatures, reaction kinetics. This course is dual-listed with an equivalent 500-level mechanical engineering courses. Pre-requisite: ME 312 Minimum Grade of D.</td>
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<tr>
<td>ME 453</td>
<td>IC Engines</td>
<td>3 cr</td>
<td>Principles for analysis and design of internal combustion (I.C.) engines. Topics: include fuel-air cycles, fuel, air and exhaust flows, heat and mass transfer, engine performance. Pre-requisite: (EG 360 Minimum Grade of D or CE 365 Minimum Grade of D or ME 324 Minimum Grade of D) and ME 312 Minimum Grade of D and ME 317 Minimum Grade of D.</td>
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<tr>
<td>ME 461</td>
<td>Turbomachinery</td>
<td>3 cr</td>
<td>Energy transfer between fluid and rotor; Fluid flow in turbomachines, centrifugal and axial flow pumps and compressors; radial and axial flow turbines. One hour of design. Pre-requisite: (EG 360 Minimum Grade of D or CE 365 Minimum Grade of D or ME 324 Minimum Grade of D) and ME 312 Minimum Grade of D.</td>
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<tr>
<td>ME 466</td>
<td>Aerospace Propulsion</td>
<td>3 cr</td>
<td>Airbreathing engines course. Apply fluids, thermodynamics, and heat transfer to analysis of air breathing engines. Topics to include: ideal cycle analysis, component performance, non-ideal cycle analysis, and blade aerodynamics. Pre-requisite: ME 312 Minimum Grade of D and ME 317 Minimum Grade of D and (EG 360 Minimum Grade of D or CE 365 Minimum Grade of D or ME 324 Minimum Grade of D).</td>
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<tr>
<td>ME 467</td>
<td>Intro to Biomedical Eng</td>
<td>3 cr</td>
<td>Survey of topics and current issues in the field of biomedical engineering. Topics include biomechanics, biomedical instrumentation, biomaterials engineering, biomedical imaging, cellular mechanics, tissue engineering, biomedical design and ethics. A portion of the course is devoted to basic biology concepts and principles. Students will review literature and discuss technical and technological developments relevant to biomedical engineering.</td>
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<tr>
<td>ME 468</td>
<td>Principles of Aircraft Design</td>
<td>3 cr</td>
<td>Introduction to aircraft design, including an understanding of the various components leading to a good conceptual design. Introduction to parameters in aerospace analysis and how they may impact a design. Application of design concepts to an RFP (request for proposal) for design competition. Pre-requisite: (ME 324 Minimum Grade of D or EG 360 Minimum Grade of D or CE 365 Minimum Grade of D) and ME 312 Minimum Grade of D and ME 317 Minimum Grade of D.</td>
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</tbody>
</table>
ME 469  Aircraft Stability and Control  3 cr
Introduction to flight dynamics of aerospace vehicles. Basic overview of stability analysis and linear feedback control. Pre-requisite: ME 328 Minimum Grade of C and EG 360 Minimum Grade of C.

ME 470  Aircraft Structural Analysis  3 cr
Introduction to elasticity. Torsion, bending and shearing of thin-walled skin-stringer structures. Failure mechanisms. Buckling of beams and plates. Introduction to finite element analysis and composite structural analysis. Pre-requisite: EG 284 Minimum Grade of C and EG 315 Minimum Grade of C and ME 328 Minimum Grade of C. ME 328 can be taken concurrently with this course.

ME 472  Vibration Analysis-Synthesis  3 cr
Steady-state and transient vibration analysis of discrete and continuous systems. Vibration problems as related to design are also included. Pre-requisite: EG 284 Minimum Grade of D and EG 315 Minimum Grade of D and ME 328 Minimum Grade of D.

ME 474  Noise and Vibration Control  3 cr
Principles of acoustics; human response to noise; control of noise and vibration by means of vibration isolation, sound barriers, and absorption. One hour of design. Pre-requisite: ME 472 Minimum Grade of D.

ME 490  Special Topics  1 TO 3 cr
Topics of current mechanical engineering interest. Pre-requisite: Consent of instructor

ME 494  Directed Studies  1 TO 3 cr
Selected mechanical engineering topics of special or current interest not available to regularly scheduled courses. Pre-requisite: Consent of instructor.

ME 499  Honors Senior Project - H  1 TO 6 cr
Under the advice and guidance of a faculty mentor, honors students will identify and carry out a research project, relevant to the field of Mechanical Engineering study, that will lead to a formal presentation at the Annual Honors Student Colloquium. The senior project will be judged and graded by three faculty, chaired by the honors mentor. This course is required for Honors recognition. A minimum of 4 credit hours is required, but students may enroll for a maximum of 6 credit hours over two semesters. Prerequisites: Completion of an approved project prospectus.

ME 518  Adv Mechanical Engr Analysis  3 cr
Application of numerical methods including finite differences; finite element and boundary element techniques to the solution of problems in Mechanical Engineering. Prerequisite: Consent of instructor.

ME 519  Computer Aided Design/Manufac  3 cr
Introduction to computer aided design (CAD) and computer aided manufacturing (CAM) principles and their practical applications as fundamental elements of contemporary product design and manufacturing. This course is dual listed with an equivalent 400-level mechanical engineering course.

ME 520  Advanced Fluid Mechanics  3 cr
Analysis of steady and unsteady motion of a viscous fluid. Topics include: conservation equations, Newtonian fluids and the Navier-Stokes equations, vorticity, analytical solutions, boundary layers, instability of viscous flows. Prerequisite: Consent of instructor.

ME 522  Gas Turbines  3 cr
Introduction to gas turbines covering thermodynamics, fluid mechanics, combustion, cycle analysis, compressors, turbines, and component matching. Pre-requisite: ME 520 Minimum Grade of C.

ME 525  Boundary Layer Theory  3 cr
Development of Navier-Stokes and boundary layer equations, perturbation theory application and boundary layer transition. Prerequisite: Consent of instructor.

ME 530  Mechanism Synthesis  3 cr
Kinematic synthesis of planar linkages for function, path, and motion generation. Topics include: degrees of freedom; graphical, linear analytical, and nonlinear analytical methods; and curvature theory. This course is dual-listed with an equivalent 400-level mechanical engineering course. Prerequisite: Consent of instructor.

ME 538  Finite Element Analysis  3 cr
Introduction to the finite element method. Engineering application to stress-strain analysis is emphasized. Other field problems are also considered. This course is dual-listed with an equivalent 400-level mechanical engineering course. Prerequisite: Consent of instructor. Pre-requisite: MA 507 Minimum Grade of C or MA 508 Minimum Grade of C or MA 507 and MA 508 can be taken concurrently with this course.

ME 539  Boundary Elements I  3 cr
Fundamental concepts of the boundary element method of numerically solving partial differential equations. Application to potential flow problems in heat transfer. This course is dual listed with an equivalent 400 level mechanical engineering course. Requires special permission of instructor.

ME 540  Advanced Heat Transfer  3 cr
Steady and transient conduction, external and internal forced convection, natural convection, radiation with participating media, boiling heat transfer, Stefan condition. Prerequisite: Consent of instructor.
<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>ME 541</td>
<td>Conduction Heat Transfer</td>
<td>3 cr</td>
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<tr>
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<td>Closed form analytical and approximate numerical solutions of one, two- and three-dimensional steady state and transient problems in conduction heat transfer. Prerequisite: Consent of instructor. Pre-requisite: MA 507 Minimum Grade of C.</td>
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<tr>
<td>ME 542</td>
<td>Convection Heat Transfer</td>
<td>3 cr</td>
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<td>Fundamental laws of motion and energy balance for a viscous fluid, classical solution of the Navier-Stokes and energy equations, laminar/turbulent hydrodynamic and thermal boundary layers, convection heat transfer in laminar/ turbulent internal flows. Prerequisite: Consent of instructor.</td>
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<tr>
<td>ME 543</td>
<td>Radiation Heat Transfer</td>
<td>3 cr</td>
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<td>Blackbody radiation, diffuse-gray surfaces, radiative exchange in a multi-surface enclosure, gas radiation in enclosures with participating media, introduction to available numerical methods. Prerequisite: Consent of instructor.</td>
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<tr>
<td>ME 544</td>
<td>Heat Trans - Change of Phase</td>
<td>3 cr</td>
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<tr>
<td></td>
<td>Boiling heat transfer and critical heat flux, condensation heat transfer, Stefan problem, freezing and melting, ablation, introduction to available numerical techniques. Prerequisite: Consent of instructor. Pre-requisite: ME 540 Minimum Grade of C or ME 542 Minimum Grade of C.</td>
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<tr>
<td>ME 545</td>
<td>Exp Fluid Mech and Heat Trans</td>
<td>3 cr</td>
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<td>Uncertainty analysis, system response, sampling theory and FFT, differential pressure measurement and multi-hole probes, thermo-couple and RTD, thermal anemometry, LDV and other non-intrusive optical methods, flow visualization. Prerequisites: Consent of instructor.</td>
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<tr>
<td>ME 550</td>
<td>Combustion</td>
<td>3 cr</td>
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<tr>
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<td>Introduction to the theory of combustion processes, chemical equilibrium, adiabatic flame temperature, reaction kinetics, flame structure. This course is dual-listed with an equivalent 400-level mechanical engineering course. Prerequisite: Consent of instructor.</td>
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<tr>
<td>ME 551</td>
<td>Classical Thermodynamics</td>
<td>3 cr</td>
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<td>Postulational treatment of the physical laws of equilibrium, equations of state, processes, equilibrium, stability, reactive systems, phase transition. Prerequisite: Consent of instructor.</td>
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<tr>
<td>ME 552</td>
<td>Statistical Thermodynamics</td>
<td>3 cr</td>
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<tr>
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<td>Principles of kinetic theory, quantum mechanics, and statistical mechanics with particular reference to thermodynamic systems. Conclusions of classical thermodynamics are established from the microscopic viewpoint. Prerequisite: Consent of instructor.</td>
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<tr>
<td>ME 553</td>
<td>IC Engines</td>
<td>3 cr</td>
</tr>
<tr>
<td></td>
<td>Principles for analysis and design of internal combustion (I.C.) engines. Topics include: fuel-air cycles, fuel, air and exhaust flows, heat and mass transfer, engine performance.</td>
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<tr>
<td>ME 560</td>
<td>Compressible Fluid Flow</td>
<td>3 cr</td>
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<td></td>
<td>Foundations of fluid dynamics and thermodynamics of one dimensional flow and heat transfer, isentropic flow, shock waves and method of characteristics. Prerequisite: Consent of Instructor.</td>
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<tr>
<td>ME 561</td>
<td>Turbomachinery</td>
<td>3 cr</td>
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<tr>
<td></td>
<td>Energy transfer between fluid and rotor; fluid flow in turbomachines, centrifugal and axial-flow pumps and compressors; radial and axial flow turbines. Prerequisite: Consent of instructor.</td>
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<tr>
<td>ME 562</td>
<td>Comp Fluid Dyn - Heat Trans I</td>
<td>3 cr</td>
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<td>Derivation of conservation equations, numerical solution of inviscid and viscous incompressible flow problems, emphasis on finite volume method, introduction to finite element and spectral method. Prerequisite: Consent of instructor.</td>
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<tr>
<td>ME 563</td>
<td>Comp Fluid Dyn - Heat Trans II</td>
<td>3 cr</td>
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<td>Governing equations in general coordinates, differential geometry for curvilinear coordinates, grid generations, numerical uncertainties. Prerequisite: Consent of instructor. Pre-requisite: ME 562 Minimum Grade of C.</td>
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<tr>
<td>ME 564</td>
<td>Turbulent Flow</td>
<td>3 cr</td>
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<td>Reynolds equations, statistics of turbulence, analysis of free and wall turbulence, turbulence models. Prerequisite: Consent of instructor. Pre-requisite: ME 520 Minimum Grade of C.</td>
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<tr>
<td>ME 565</td>
<td>Lubrication</td>
<td>3 cr</td>
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<td>ME 566</td>
<td>Aerospace Propulsion</td>
<td>3 cr</td>
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<td>Airbreathing engines course. Apply fluids, thermodynamics, and heat transfer to analysis of air breathing engines. Topics to include: ideal cycle analysis, component performance, non-ideal cycle analysis, and blade aerodynamics.</td>
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<tr>
<td>ME 567</td>
<td>Principles Biomedical Eng</td>
<td>3 cr</td>
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<td>Survey of topics and current issues in the field of biomedical engineering. Topics may include biomechanics, biomedical instrumentation, biomaterials engineering, biomedical imaging, cellular mechanics, tissue engineering, biomedical design and ethics. A portion of the course is devoted to basic biology concepts and principles. Students will review literature and discuss technical and technological developments relevant to biomedical engineering.</td>
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<tr>
<td>ME 569</td>
<td>Aircraft Stability and Control</td>
<td>3 cr</td>
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<tr>
<td></td>
<td>Introduction to flight dynamics of aerospace vehicles. Basic overview of stability analysis and linear feedback control. Co-requisite: MA 507</td>
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ME 571 Advanced Engineering Dynamics 3 cr
Three-dimensional kinematics and kinetics of particles and rigid bodies, energy, momentum, and stability; application of Lagrange’s equations to machinery and gyrodynamics. Prerequisite: Consent of instructor.

ME 572 Advanced Vibrations 3 cr
Free and forced vibrations of mechanical systems having lumped mass and elasticity; introduction to vibrations of continuous systems; engineering applications. Prerequisite: Consent of instructor.
Pre-requisite: MA 507 Minimum Grade of C or MA 508 Minimum Grade of C. MA 507 and MA 508 can be taken concurrently with this course.

ME 573 Vibrations of Continuous Sys 3 cr
Equations of motion for strings, membranes, bars, and plates with various boundary conditions, steady state and transient solutions, exact and approximate methods; wave propagation in elastic media. Prerequisite: Consent of instructor.
Pre-requisite: MA 507 Minimum Grade of C.

ME 574 Nonlinear Vibrations 3 cr
Vibrations of damped and undamped systems with nonlinear restoring forces; free and forced oscillations in self-sustained systems; Hill’s equation and its application to the study of the stability of nonlinear oscillations. Prerequisites: Consent of instructor.
Pre-requisite: ME 572 Minimum Grade of C and MA 508 Minimum Grade of C.

ME 575 Continuum Mechanics 3 cr
Cartesian tensor analysis. Analysis of stress and strain, fundamental laws of continuum mechanics. Constitutive equations, application to solid and fluid mechanics. Prerequisite: Consent of instructor.

ME 576 Advanced Materials Science 3 cr
Classical and quantum mechanical model of atoms, bonding, magnetism, superconductivity, high strength low density materials, corrosion, biomedical materials. Prerequisite: Consent of the instructor.

ME 577 Applied Elasticity 3 cr
Classical problems in elasticity, torsion and bending theory, plane problems in rectangular and polar coordinates; axisymmetric problems, thermoelasticity. Prerequisite: Consent of instructor.
Pre-requisite: MA 507 Minimum Grade of C or MA 508 Minimum Grade of C. MA 507 and MA 508 can be taken concurrently with this course.

ME 578 Theory of Plates 3 cr
Basic equations of rectangular and circular plates with various boundary conditions; classical solutions and approximate methods in the theory of thin plates. Prerequisite: Consent of instructor.
Pre-requisite: MA 507 Minimum Grade of C.

ME 579 Theory of Shells 3 cr
Introduction to differential geometry; general equations for arbitrary shells; shallow shell theory with applications; solutions to membrane and bending theory for shells of revolution. Prerequisite: Consent of instructor.
Pre-requisite: ME 585 Minimum Grade of C.

ME 580 Microwave Engineering 3 cr
Fundamentals of microwave engineering, basic concepts of wave propagation in the microwave region, basic theories of microwave devices, basic concepts of circuit analysis, and application to microwave circuits. Prerequisite: Consent of instructor.

ME 581 Antennas and Transmitters 3 cr
Fundamentals of antennas, including the principles of wave propagation, radiation, and reception. Prerequisite: Consent of instructor.

ME 582 Theory of Vibrations 3 cr
Fundamentals of vibration theory, including the principles of wave propagation, radiation, and reception. Prerequisite: Consent of instructor.

ME 583 Finite Element Method 3 cr
Introduction to finite element method, including the principles of wave propagation, radiation, and reception. Prerequisite: Consent of instructor.

ME 584 Thermal Analysis 3 cr
Fundamentals of thermal analysis, including the principles of wave propagation, radiation, and reception. Prerequisite: Consent of instructor.

ME 585 Engineering Laboratory 3 cr
Fundamentals of engineering laboratory, including the principles of wave propagation, radiation, and reception. Prerequisite: Consent of instructor.

ME 586 Nonlinear Vibrations 3 cr
Vibrations of damped and undamped systems with nonlinear restoring forces; free and forced oscillations in self-sustained systems; Hill’s equation and its application to the study of the stability of nonlinear oscillations. Prerequisites: Consent of instructor.
Pre-requisite: MA 507 Minimum Grade of C.

ME 587 Applied Vibrations 3 cr
Fundamentals of applied vibrations, including the principles of wave propagation, radiation, and reception. Prerequisite: Consent of instructor.

ME 588 Design and Analysis of Structures 3 cr
Fundamentals of design and analysis of structures, including the principles of wave propagation, radiation, and reception. Prerequisite: Consent of instructor.

ME 589 Advanced Engineering Dynamics 3 cr
Advanced topics in engineering dynamics, including the principles of wave propagation, radiation, and reception. Prerequisite: Consent of instructor.

ME 590 Advanced Vibration Analysis 1 TO 3 cr
Topics of current mechanical engineering interest. Prerequisite: Consent of instructor.

ME 591 Advanced Vibration Analysis 1 TO 3 cr
Topics of current mechanical engineering interest. Prerequisite: Consent of instructor.

ME 592 Directed Independent Study 1 TO 3 cr
Directed study, under the guidance of a faculty advisor, of a topic from the field of Mechanical Engineering not offered in a regularly scheduled course. Requires permission of the instructor.

ME 593 Directed Independent Study 1 TO 3 cr
Directed study, under the guidance of a faculty advisor, of a topic from the field of Mechanical Engineering not offered in a regularly scheduled course. Requires permission of the instructor.

ME 594 Projects in Mechanical Engr 1 TO 3 cr
May be repeated for credit. Prerequisite: Approved proposal and consent of director of engineering graduate studies.

ME 595 Thesis 1 TO 6 cr
Thesis research may be taken more than once. Prerequisite: Approved prospectus.

Systems Engineering (SE)

SE 500 Engr Probability & Statistics 3 cr
Probability and statistical concepts; discrete, continuous, and joint distributions; point and interval estimation; hypothesis testing; regression and correlation analysis; analysis of variance.

SE 501 Engineering Optimization 3 cr
Model construction, linear programming, network models, dynamic models, stochastic models, queuing theory, and decision theory. Prerequisite: SE 500 Minimum Grade of B. SE 500 can be taken concurrently with this course.

SE 601 Systems Eng Fundamentals 3 cr
Fundamentals of systems engineering, structure of complex systems, system development process, systems engineering management and documentation, needs analysis, requirements development, engineering design and development, integration and test, change management, process improvement. Fee.
SE 602 Risk and Failure Analysis  3 cr
Risk Analysis needs, risk analysis methods, performance requirement analysis, trade studies, failure analysis needs, failure analysis tracking, and failure analysis methods. Pre-requisites: Requires a background in calculus-based statistics and permission of instructor. Fee.

SE 603 Integration, Test & Evaluation  3 cr
Interface control documents, design reviews, requirements management, allocation of test methods to requirements, test plans, test procedures, test execution, and failure tracking and resolution. FEE Pre-requisite: SE 601 Minimum Grade of C.

SE 604 Software Systems Engineering  3 cr
Software development methodologies, software development tools, change management, software concept development, software requirements development and allocation, coding and unit test, program technical interfaces, software engineering management. Fee. Pre-requisite: SE 601 Minimum Grade of C.

SE 605 Project Engineering  3 cr
Management of system design, development and risk, work breakdown, structure, systems engineering management plan, design reviews, budget and schedule analyses, negotiation and conflict resolution, contracts, customer interactions, team selection, failure resolution. Fee.

SE 606 Systems Architecture  3 cr
The systems architecture is that foundational structure of a system, capturing the core capability and structure of the system. This course will cover principles of systems architecting, system architecture drivers, relationship of systems architecture to system requirements, common tools and techniques to include design structure matrices, IDEF0, SysML, and simulation. Pre-requisite: SE 601 Minimum Grade of C.

SE 607 Systems Simulation  3 cr
This course rigorously examines system modeling and simulation methodologies, emphasizing statistical analysis and discrete-event simulation via simulation software.

SE 608 Reliability Engineering  3 cr
This course rigorously examines reliability and maintainability methodologies, emphasizing mathematical constructs, design concepts, and data analysis employed to quantify reliability, availability, and maintainability measures for operational readiness, support system design, and system effectiveness.

SE 609 Engineering Research Methods  1 TO 3 cr
This course is a fast tracked course examining quantitative and qualitative methods for conducting meaningful inquiry and research. Topics include research ethics, intent, design, methodologies, techniques, formatting, data management, analysis, publication, and presentation utilizing common statistical approaches.

SE 610 Systems Thinking  3 cr
The act of systems thinking is taking a step back from the details considered during engineering design, and looking at the whole picture. This class exposes the student to a conceptual framework to allow them to properly define complex systems and enterprises drawing from synthesizing techniques from systems science, soft systems methodologies, and systems engineering. The class demonstrates the ability to leverage the simultaneity of perspectives, the role of paradox, and the centrality of soft issues in resolving complexity.

SE 611 Socio-Technical Systems  3 cr
Socio-Technical systems are those systems which contain and/or are strongly influenced by human, social and institutional elements. Because of those influences, they quickly become dependent on community partnerships, infrastructure constraints, and government-aspects that are not traditionally part of the engineering equation. This course considers the systems engineering approach as it relates to the challenges of socio-technical systems. Pre-requisite: SE 601 Minimum Grade of C.

SE 612 Production System Engineering  1 TO 3 cr
This course rigorously examines principles, design, models and techniques for operational planning and analysis of production and distribution systems emphasizing quantitative methods.

SE 690 Special Topics in SE  3 cr
Topics of current interest in Systems Engineering. Fee.

SE 692 Directed Studies  3 cr
Directed study, under the guidance of a faculty advisor, of a topic from the field of Systems Engineering not offered in a regularly scheduled course. Prerequisite: Instructor's permission.

SE 699 Dissertation  1 TO 6 cr
An investigation of an original problem in Systems Engineering under the guidance of the student's major professor. Prerequisite: Approval of the dissertation prospectus by the student's Advisory Committee, the Graduate School, and consent of the Director of Engineering Graduate Studies.

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MS, Virginia Polytechnic Inst and
PHD, Clemson University

PHAN, ANH-VU
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MS, Grenoble Inst of Technology
PHD, University of Montreal

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MBA, Eastern University
PHD, Stevens Inst of Technology

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PHD, University of Alabama

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PHD, University of Delaware

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PHD, Vanderbilt University

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PHD, University of Louisville

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PHD, Brown University

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MSME, Sungkyunkwan Univ - Korea
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