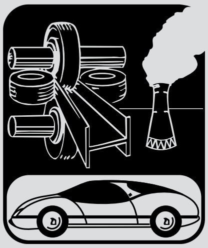

Engineering – Mechanical

College of Engineering and Computer Science

Bachelor of Science
Master of Science

PROGRAM DESCRIPTION

Mechanical Engineering involves the design of all types of machines and equipment including vehicles used in ground, air and space transportation; machines for the conversion of fuels into energy; consumer products; robots; biomedical devices; the machines used to manufacture all of the above; and the climate control of buildings. Mechanical engineers bring together the fields of design graphics, manufacturing, engineering materials, thermodynamics and heat transfer, and the principles of mathematics and science to find solutions to human needs. They often work directly in the design and operation of food processing plants, power plants, manufacturing plants, refineries and other industrial operations. A major goal of the curriculum is to provide the graduates with the analytical and practical skills needed to perform mechanical design in a variety of fields, thus taking advantage of the many employment opportunities.

The Mechanical Engineering Program includes courses on design, energy conversion, manufacturing, properties and selection of materials, and the application of computers to these topics. The curriculum maintains a balance among basic fundamentals, analytical methods and design applications of current knowledge, preparing the graduates for both entry into the profession and a life-long career.

Career Possibilities

Aeronautical Engineer • Automotive Engineer • Design Engineer • Development Engineer • Engineering Manager • Environmental Engineer • Machine Designer • Manufacturing Engineer • Plant Engineer • Project Engineer • Research Engineer • Technical Sales Engineer

Faculty

Robin Bandy, James Bergquam, Jose Granda, Joseph Harralson, Susan Holl, Akihiko Kumagai, Tien-I Liu, Thinh Dinh Ngo, Frederick H. Reardon, Kenneth Sprott, Yong Suh, Tong Zhou

Contact Information

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The employers of Mechanical Engineering graduates include aircraft and automobile companies, food processing companies, machinery and equipment companies, gas and electric utilities, architectural and engineering firms, and many agencies in federal, state and local governments. Some graduates continue their education by completing advanced degrees in Engineering or Management.

Specializations

- **MS:** Design and Dynamic Systems; Manufacturing; Thermal and Fluid Systems

Special Features

- The Mechanical Engineering program is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (EAC/ABET), 111 Market Place, Suite 1050, Baltimore, Maryland 21202, (410) 347-7700. In keeping with its accreditation, the Mechanical Engineering program has strong engineering design content. In particular, the program includes a four-semester sequence on modern design and manufacturing methods.
- Faculty members have backgrounds in Mechanical, Aeronautical, Manufacturing, and Materials Science engineering. The faculty has a variety of research interests; the majority has industrial experience which contributes to the applied emphasis in the Mechanical Engineering program. Most of the faculty has doctorates; some are registered engineers.
- With most lecture classes having enrollments of 30 to 35, students can participate in meaningful discussions and a real exchange of ideas between students and faculty.
- Upper division students do cooperative work on team projects and often develop study groups in other courses.
- Courses taken in the freshman and sophomore years form a foundation for the upper division (Junior-Senior) program; e.g., the dynamics and strength of materials studied in the junior year depend on the sophomore statics, calculus, and physics courses. Building on analytical and communications skills learned in the lower division, students take a four semester design-project sequence which includes the study of design methods, and the procedures for developing a design solution from concept through a fully-developed design and finally to production. The courses in mechanics, energy transformation, manufacturing and materials support this sequence.
- Students can achieve a level of specialization through elective courses in computer analysis, heating, ventilating and air-conditioning, manufacturing methods, and systems and materials engineering.

Program Educational Objectives

The objectives of this program are to prepare graduates to:

- enter professional employment and/or graduate study in the following areas of mechanical engineering practice: machine design, thermal and fluid systems, materials, and manufacturing;
- identify, formulate, and solve practical problems, making use of appropriate computer technology;
- apply creativity in the design process, functioning cooperatively within multi-disciplinary teams;
- communicate effectively through speaking, writing, and graphics; and
- use their understanding of professional, ethical, and social responsibilities and the importance of life-long learning in the conduct of their professional careers.

Academic Policies and Procedures

Course Repeat Policy - Undergraduate engineering and mechanical engineering courses that are used to meet the Bachelor of Science in Mechanical Engineering degree requirements may be repeated only twice (for a total of three attempts). Grades of the second and third attempts will be averaged in grade point calculations.

Incomplete Grades - Incomplete grades are issued only in accordance with University policy. The student must be passing the course at the time an "Incomplete" is requested. An Incomplete Petition must be submitted to the Department with the student's and the course instructor's signature. The Incomplete Petition (obtained in the Department office) must specify the work to be completed, the basis by which the student's final grade will be determined, and the last date for completion of the incomplete work. An incomplete grade that is not cleared by the set date will lapse to an "F" grade.

UNDERGRADUATE PROGRAM

Sequence of Study: Courses taken in the Freshman and Sophomore years, either at Sacramento State, or at a Community College or transfer college, directly contribute to the upper division (Junior-Senior) program. For example, upper division work in Computer-Aided Design (CAD) develops skills introduced in freshman graphics and CAD courses; upper division analytical courses depend on the freshman and sophomore statics, calculus, and physics courses. Communication skills learned in the lower division are developed through the writing of memoranda and reports, and oral presentations.

Mechanical Engineering design involves far more than solving the types of problems found in chemistry, physics, and calculus courses; design work involves a large measure of intuitive and creative work. The principles of mathematics and science are extremely useful when developing a detailed design solution but contribute little to the critical issues of correctly defining the problem, listing needed concepts, and locating and organizing needed information. In addition, the design cannot violate fundamental physical laws and must be built from real materials using real manufacturing methods at a reasonable cost while satisfying safety and environmental factors.

The work in the four semester design-project sequence and other courses addresses these issues by including the study of design methods, procedures for developing a design solution from concept through a fully-developed design and construction of a prototype. The courses in mechanics, thermodynamics, manufacturing and materials, complement the design sequence. The design work includes a mixture of problem and project work in individual courses; some of the course-level projects are team projects to help the student develop the ability to efficiently and effectively work with other engineers making decisions, use the abilities of different people, and distribute the work of large projects. The second and third design sequence, and other courses include classical and computer aided design analysis techniques. The work in the two-semester, capstone, senior project sequence involves team effort on a significant design problem. Students interested in furthering their skills in analysis, including finite element analysis and dynamic modeling of systems, can choose from a number of elective courses which rely heavily on computer methods.

Advising: Each student has a faculty advisor who meets with him/her at least once a semester to discuss academic progress, plan the following semester, explain University requirements and answer questions about the Mechanical Engineering program.

Requirements • Bachelor of Science Degree

Units required for Major: 56
Units required for Pre-Major: 45
Minimum total units required for the BS: 137
A grade of "C-" or better is required in all courses applied to a Mechanical Engineering major.
Additional units may be required to meet the Sacramento State foreign language requirement

Courses in parentheses are prerequisites.

A. Required Lower Division Courses (Pre-Major)

Lower division requirements are essentially common for Civil, Electrical and Electronic, and Mechanical Engineering.

First Semester Freshman Year (18 units)

(5)	CHEM 1A*	General Chemistry I (High school algebra (two years) and high school chemistry, or equivalent)
(3)	ENGR 6	Engineering Graphics and CADD – Computer Aided Drafting and Design
(4)	MATH 30*	Calculus I (MATH 29 or four years of high school mathematics which includes two years of algebra, one year of geometry, and one year of mathematical analysis; completion of ELM requirement and Pre-Calculus Diagnostic Test)
(3)	General Education course	
(3)	General Education course	

Second Semester Freshman Year (17 units)

(3)	ENGL 20	College Composition II (ENGL 1A with a grade "C-" or better, or equivalent)
(4)	MATH 31*	Calculus II (MATH 30 or appropriate high school based AP credit)
(3)	ME 37	Manufacturing Processes
(4)	PHYS 11A*	General Physics: Mechanics (MATH 30, MATH 31; or equivalent certificated high school courses. MATH 31 may be taken concurrently)
(3)	General Education course	

First Semester Sophomore Year (17 units)

(3)	ENGR 45	Engineering Materials (PHYS 11A, CHEM 1A; CHEM 1A may be taken concurrently)
(4)	MATH 32	Calculus III (MATH 31)
(4)	PHYS 11C*	General Physics: Electricity and Magnetism, Modern Physics (MATH 31, PHYS 11A)
(3)	General Education course	
(3)	General Education course	

Second Semester Sophomore Year (14 units)

(3)	ENGR 17	Introductory Circuit Analysis (PHYS 11C, MATH 45; either the math or physics may be taken concurrently, but not both)
(3)	ENGR 30	Analytic Mechanics: Statics (PHYS 11A, MATH 31, ENGR 6)
(3)	MATH 45	Differential Equations for Science and Engineering (MATH 31)
(2)	ME 75	Introduction to Computer Aided Engineering (MATH 30, PHYS 11A; PHYS 11A may be taken concurrently)
(3)	General Education course	

*Course may also satisfy General Education requirements. A second year foreign language course may also satisfy 3 units of GE when the course is being taken to comply with the Sacramento State foreign language requirement. Students should consult with an advisor for exact GE eligibility of these courses.

Note: Courses are listed in a recommended sequence, and may be interchanged among semesters to accommodate the student's schedule, **as long as prerequisites are met.**

B. Required Upper Division Courses (Major)

Students are allowed to enroll in upper division Engineering or Mechanical Engineering courses with the Department's approval. Pre-Major students must complete a Change of Major form and submit it to the Mechanical Engineering Department Office during the application filing period.

First Semester Junior Year (17 units)

(3)	ENGR 110	Analytic Mechanics - Dynamics (ENGR 30, MATH 32, MATH 45)
(3)	ENGR 112	Mechanics of Materials (ENGR 30, ENGR 45, MATH 45)
(2)	ENGR 115	Statistics for Engineers (MATH 31, may be taken concurrently)
(3)	ENGR 124	Thermodynamics (CHEM 1A, MATH 32, PHYS 11A)
(3)	ME 118	Product Design I (ENGR 6, ENGR 45, ME 37)
(3)	ME 175	Computer Applications in Mechanical Engineering (ME 75 or CSC 15 or CSC 25, and ENGR 17, ENGR 30, ENGR 45)

Second Semester Junior Year (18 units)

(3)	ENGR 132	Fluid Mechanics (ENGR 110)
(3)	ME 115	Dynamics of Machinery (ENGR 6, ENGR 110, ME 175)
(3)	ME 119	Product Design II (ENGR 112, ME 75, ME 118)
(2)	ME 125	Mechanical Engineering Measurements (ENGR 124, ENGR 132, ME 175; ENGR 132 may be taken concurrently)
(3)	ME 127	Intermediate Thermodynamics (ENGR 124, ENGR 132, ME 125; ENGR 132 and ME 125 may be taken concurrently)
(4)	ME 180	Mechanical Properties of Materials (ENGR 112 and passing score on WPE)

First Semester Senior Year (18 units)

(3)	ME 114	Vibrations and Controls (ENGR 110, ME 175) **OR**
	ME 171	Computer Modeling and Design of Dynamic Systems (ENGR 110, ME 175)
(3)	ME 126	Heat Transfer (ENGR 124, ENGR 132, ME 75)
(3)	ME 138	Concurrent Product and Process Design (ME 118 or MET 164; ME 118 or MET 164 may be taken concurrently)
(3)	ME 190	Project Engineering I (ME 115, ME 119, ME 126, ME 138; passing score on WPE; ME 126 and ME 138 may be taken concurrently)
(3)	General Education course	
(3)	General Education course	

Second Semester Senior Year (18 units)

(3)	ME 191*	Project Engineering II (ME 190)
(3)	ME elective	
(3)	ME elective	
(3)	General Education course	
(3)	General Education course	
(3)	General Education course	

*Course may also satisfy General Education requirements.

C. Mechanical Engineering Electives

ME 136	Numerical Control Programming (ME 37; and ME 175 or MET 173; ME 175 or MET 173 may be taken concurrently)
ME 137	Product Design for Manufacturing and Automation (ME 119 or MET 166)
ME 143	Vehicle Design (ME 119 or MET 166 ; may be taken concurrently)
ME 151	Fundamentals of Combustion (ME 127 or MET 142; may be taken concurrently)
ME 152	Turbomachinery Design (ME 127, ME 175)
ME 153	Thermodynamics of Combustion Engines (ME 175 , ENGR 124, ENGR 132; or MET 140, MET 141, MET 173)
ME 155	Gas Dynamics (ME 127, ME 175)
ME 156	Heating and Air Conditioning Systems (ENGR 124, ENGR 132)
ME 157	Solar Energy Engineering (ME 126; may be taken concurrently)
ME 159	High Efficiency HVAC (ME 156 or instructor permission)
ME 165	Introduction to Robotics (ME 114, ME 115)
ME 170	Introduction to Computer Aided Design (ENGR 6, ENGR 110, ENGR 112, ME175)
ME 173	Applications of Finite Element Analysis (ENGR 112, ME 175)
ME 176	Product Design and Pro/Engineer (ENGR 6, ME 115 , ME 175)
ME 182	Introduction to Composite Materials (ME 180)
ME 184	Corrosion and Wear (ME 180)
ME 186	Fracture Mechanics in Engineering Design (ME 180)

ME 188	Engineering Design with Ceramics (ME 180) **OR** upper division courses in Engineering, Mathematics and Science may be selected with prior approval by the student's advisor.

Note: Elective courses are offered on a four semester rotation. The Mechanical Engineering Department Office maintains a listing showing when particular courses will be offered.

Cooperative Education (Pre-Work Experience)

The Department of Mechanical Engineering encourages students to participate in the Cooperative Education Program, which provides alternate periods of university study and major-related, off-campus, paid employment in industry. Most students who elect to participate in cooperative education will complete the equivalent of two 6-month work periods before graduation. Students interested in the Cooperative Education Program should apply in the satellite office in Riverside Hall 2004, or the main office in Lassen Hall 2008. For information, call (916) 278-7234.

GRADUATE PROGRAM

The Master of Science program in Mechanical Engineering prepares students for leadership in the practice of mechanical engineering. The program includes the study of scientific and technical principles underlying modern engineering practice and advanced mathematical techniques needed for their application in research and design.

Specializations

Three areas are offered as specializations: Design and Dynamic Systems; Manufacturing; and Thermal and Fluids Systems. In each area there are specific course requirements to be met; all three specializations encompass Engineering Design.

Elective courses allow for the development of each student's particular interests. An individual's applied research or design study, presented in a Master's thesis or project, complements the formal class work and completes the program.

Admission Requirements

Admission as a classified graduate student in Mechanical Engineering requires:

- a Bachelor of Science degree in Engineering or Computer Science;
- a minimum GPA of 3.0 in upper division engineering courses, and
- (for foreign students only) a TOEFL score of 550.

Applicants who do not meet the three admission requirements listed above because they have a Baccalaureate degree in a field other than Engineering or Computer Science, and/or because their GPA is below 3.0 but above 2.5 in the last 60 units of undergraduate work, may be admitted with conditionally classified status. Any deficiencies will be noted in a written response to the applicant.

If a student lacks some of the undergraduate courses needed for successful completion of the graduate program, such prerequisite courses must be taken before the student can be fully accepted to the program.

Admission Procedures

Applications are accepted as long as space for new students exists. However, students are strongly urged to apply by April 1 for the following fall or October 1 for the following spring in order to allow time for the registration deadline. All prospective graduate students, including Sacramento State graduates, must file the following with the Office of Graduate Studies, River Front Center 206, (916) 278-6470:

- an online application for admission;
- two sets of official transcripts from all colleges and universities attended *other than Sacramento State;* and
- (for foreign students only) TOEFL scores.

Approximately six weeks after receipt of all items listed above, a decision regarding admission will be mailed.

Advancement to Candidacy

Each student must file an application for Advancement to Candidacy, indicating a proposed program of graduate study. This procedure should begin as soon as the classified graduate student has:

- removed any deficiencies in admission requirements;
- completed at least 12 units in the graduate program with a minimum 3.0 GPA, including at least 9 units at the 200 level;
- obtained approval of a thesis/project topic using the Department of Mechanical Engineering Master's Thesis/Project Approval Form; and
- passed the Writing Proficiency Examination (WPE) or secured approval for a WPE waiver.

Advancement to Candidacy forms are available in the Office of Graduate Studies. The student fills out the form after planning a degree program in consultation with a faculty advisor. After approval by the Mechanical Engineering Graduate Coordinator, the form is then returned to the Office of Graduate Studies for approval.

Requirements • Master of Science Degree

Units required for MS: 30
Minimum required GPA: 3.0

A. Required Core Courses (7 units)

(3)	ENGR 201	Engineering Analysis I (MATH 45)
(3)	ENGR 202	Engineering Analysis II (MATH 45) **OR**
	ME 206	Stochastic Modeling for Engineers (MATH 45 or equivalent)
(1)	ME 209	Research Methodology (Graduate standing in Mechanical Engineering)

B. Additional Requirements for Specializations (9 units)

Select at least three courses from one of the three following areas of study:

Design and Dynamic Systems

This area focuses on the design of products and on the manufacturing systems needed for their production. Classical and computer-aided techniques are studied to provide a strong background in mechanical design theory and practice. Industrial software tools are used to perform finite-element modeling, dynamic system analysis and optimum design.

ME 240	Mechanical Design Analysis (ME 119, ENGR 201; ENGR 201 may be taken concurrently)
ME 241	Optimum Mechanical Design (ME 119, ENGR 201; ENGR 201 may be taken concurrently)
ME 270	Advanced Computer-Aided Design of Dynamic Systems (ME 114, ME 170 or ME 171)
ME 272	Finite Element Modeling in Computer-Aided Design (ME 173, ME 175)
ME 276	Advanced Vibration Theory (ME 114, ME 171, or CE 166)

Manufacturing

This area includes the use of mathematical methods as well as current computer techniques to solve problems encountered in planning, designing, and/or controlling manufacturing systems. Study of the techniques for product design and Manufacturing, Neural Networks, Artificial Intelligence and Industrial Management is conducted.

ME 233	Intelligent Product Design and Manufacturing (ME 138, ME 175)
ME 237	Digital Control of Manufacturing Processes (ME 138, ME 175, MATH 45)
ME 238	Automated Inspection (ME 138, ME 175)

Thermal and Fluid Systems

This area concentrates on the principles of thermodynamics, heat transfer, and fluid mechanics as applied to such products as heat exchangers, internal combustion engines, gas turbines, and solar energy systems. Courses make use of computational fluid dynamics (CFD) and finite element analysis (FEA) software tools to explore the behavior of a variety of thermal energy conversion systems and components. In this area of interest, innovative system design is becoming more important as progress is made toward increasing the efficiency of thermal systems while reducing the adverse effects on the environment.

ME 250	Heat Transfer: Conduction (ME 126, ENGR 202; ENGR 202 may be taken concurrently)
ME 251	Heat Transfer: Convection (ME 126, ENGR 201; ENGR 201 may be taken concurrently)
ME 252	Heat Transfer: Radiation (ME 126, ENGR 202)
ME 253	Advanced Fluid Mechanics (ENGR 132, graduate standing)
ME 256	Mechanics and Thermodynamics of Compressible Flow (ME 127, ENGR 201 or ENGR 202; ENGR 201 or ENGR 202 may be taken concurrently)
ME 258	Advanced Thermodynamics (ME 127, ENGR 202)
ME 272	Finite Element Modeling in Computer-Aided Design (ME 173, ME 175)

C. Electives (9-12 units)

Select 9 or 12 units of courses in consultation with faculty advisor. Upper division undergraduate courses may be used as elective courses. However, no course can be used for both undergraduate and graduate credit. Students choosing the thesis option must take 9 units of electives and students taking the project option must take 12 units of electives.

D. Culminating Requirement (2-5 units)

Select **one** of the following two options:

Plan A: Master's Thesis (5 units). Under Plan A the student's program consists of the following minimum requirements:

Core courses	(7 units)
Specialty Area	(9 units)
Electives	(9 units)
ME 500	(5 units)

Thesis defense/presentation: The Thesis (Plan A) must be orally presented and defended, approved by the student's Thesis Committee and approved by the ME Graduate Coordinator or the Department Chair prior to submittal of the thesis to the Office of Graduate Studies.

Plan B: Master's Project (2 units). Under Plan B the student's program consists of the following minimum requirements:

Core courses	(7 units)
Specialty Area	(9 units)
Electives	(12 units)
ME 500	(2 units)

Project presentation: The Project (Plan B) is to culminate in a Master's Project Report that must be orally presented. The Project Report must be approved by the ME Graduate coordinator or the Department Chair prior to submittal to the Office of Graduate Studies.

Notes:

- The student cannot register for the culminating experience (ME 500), until he/she has passed the Writing Proficiency Exam (WPE), and has been advanced to candidacy. Prior to registering for ME 500, the student must choose Plan A, Master's Thesis (5 units), or Plan Master's Project (2 units), by submitting a proposed topic form to the department office. In subsequent semesters, students will enroll in ME 299, after qualifications for enrollment have been verified. As soon as possible after the student has registered for ME 500, it is expected that the student will select a committee appropriate to the chosen plan of study.
- The Thesis Committee consists of the student's Thesis Advisor, who is the Chairperson of the Thesis Committee, and two other faculty members.
- The Project Committee consists of the student's Project Advisor, who is the Chairperson of the Project Committee, and one other faculty member.
- **Advising:** The Department of Mechanical Engineering has a Graduate Coordinator who is the liaison between each graduate student and the Office of Graduate Studies. After advancing to candidacy (see above), the student proceeds with research for the thesis/project. Guidance of this phase of study is done by a faculty member with expertise in the particular thesis/project topic.

Lower Division Courses

ME 37. Manufacturing Processes. Principles of manufacturing processes in the areas of metal removal, forming, joining and casting and fundamentals of numerical control. Study includes applications of equipment, e.g., lathe, milling machine, drill press, saw, grinder, welder, molding equipment and core makers. Emphasis on safety during hands-on operations. Two hours lecture, one three-hour lab. **Units:** 3.0.

ME 75. Introduction to Computer Aided Engineering. Introduction to the use of computers for engineering, science and mathematical computations. Provides basic computer operation skills, and includes the use of modern interactive symbolic and numerical computation packages as well as an introduction to programming methods for solving problems. The use of graphical visualization tools for output will be emphasized. Sample applications will be drawn from a variety of science and engineering areas. Lecture one hour, laboratory three hours. **Prerequisite:** MATH 30, PHYS 11A; PHYS 11A may be taken concurrently. **Units:** 2.0.

Upper Division Courses

ME 114. Vibrations and Controls. Generation of motion equations of mechanical single and multiple degree freedom systems; natural frequencies, eigenvectors, free and forced response, and vibration isolation; fundamentals of control systems, Laplace transforms, frequency response methods, error analysis, and design of compensating controls; root locus methods, and stability of linear control systems. **Prerequisite:** ENGR 110, ME 175. **Units:** 3.0.

ME 115. Dynamics of Machinery. Analysis and synthesis of linkages, cams and gear teeth for displacement, velocity and acceleration. Analyzes applied and inertia forces in machinery; balancing; elements of vibration. Lecture three hours. **Prerequisite:** ENGR 6, ENGR 110, ME 175. **Units:** 3.0.

ME 118. Product Design I. Introduction to basic design methodology for mechanical systems and devices. A broad overview of complex machine design, from concept to production, including: creativity, project planning, engineering graphics, and analysis strategies of complex devices. Integration of engineering science into product design, including: design methodologies, document controls, packaging and layout design, design for production, failure mode and effects analysis (FEMA), and project management. Lecture two hours; laboratory three hours. **Prerequisite:** ENGR 6, ENGR 45, ME 37. **Units:** 3.0.

ME 119. Product Design II. Detail design of machine components; application of analytical methods in the design of complex machines. Failure mode analysis, theories of failure, yield, fracture, deflection, and fatigue analysis of machine elements. Introduction to computer methods of stress and deflection analysis using finite element analysis (FEA). Factors of safety in design, detail design methods for specific components such as bearings and gears. Start of senior design project. Lecture two hours; laboratory three hours. **Prerequisite:** ENGR 112, ME 75, ME 118. **Units:** 3.0.

ME 125. Mechanical Engineering Measurements. Theory and practice of instrumentation for basic temperature, acceleration, pressure, flow, force, and strain applied to mechanical engineering problems. Lecture one hour; laboratory three hours. **Prerequisite:** ENGR 124, ENGR 132, ME 175; ENGR 132 may be taken concurrently. **Units:** 2.0.

ME 126. Heat Transfer. Basic principles of heat transfer, including processes of conduction, convection, radiation, evaporation and condensation. Lecture three hours. **Prerequisite:** ENGR 124, ENGR 132, ME 75. **Units:** 3.0.

ME 127. Intermediate Thermodynamics. Advanced topics in thermodynamics, including compressible flow in ducts and nozzles, reactive systems, homogeneous equilibrium. **Prerequisite:** ENGR 124, ENGR 132, ME 125; ENGR 132 and ME 125 may be taken concurrently. **Units:** 3.0.

ME 136. Numerical Control Programming. Computer programming languages for automated manufacturing, including CNC manual programming, cutter compensation, geometric definition of products, cutting tool definition, continuous path part programming, computation, decision, looping, computer graphics programming and intelligent machines. **Prerequisite:** ME 37; and ME 175 or MET 173; ME 175 or MET 173 may be taken concurrently. **Units:** 3.0.

ME 137. Product Design for Manufacturing and Automation. Various manufacturing and automation aspects of product design, including design for machining, design for automation, applications of CAD/CAM software in product design and automation, and rapid prototyping. Virtual design and manufacturing and agile manufacturing will also be discussed. **Prerequisite:** ME 119 or MET 166. **Units:** 3.0.

ME 138. Concurrent Product and Process Design. Manufacturing considerations in product design including: design for assembly DFA), design for productibility (DFP), design to cost (DTC), design to life cycle cost (DTLCC), design for quality and reliability (DFQR); introduction to concurrent engineering. **Prerequisite:** ME 118 or MET 164; ME 118 or MET 164 may be taken concurrently. **Units:** 3.0.

ME 143. Vehicle Design. Design of vehicles with emphasis on, but not limited to, automobiles. Major topics include frame design, suspension, power plants, power transmission, steering, braking, auxiliary systems, and manufacturing methods. **Prerequisite:** ME 119 or MET 166; may be taken concurrently. **Units:** 3.0.

ME 151. Fundamentals of Combustion. Principles of combustion and pyrolysis of gaseous, liquid, and solid materials. Applications of principles, including analysis and design of stationary and mobile powerplants, waste management, and fire safety. **Prerequisite:** ME 127 or MET 142; may be taken concurrently. **Units:** 3.0.

ME 152. Turbomachinery Design. Theoretical analysis of energy transfer between fluid and rotor; principles of axial, mixed, and radial flow compressors and turbines. Applications and computer-aided design of various types of turbomachines. **Prerequisite:** ME 127, ME 175. **Units:** 3.0.

ME 153. Thermodynamics of Combustion Engines. Application of thermodynamic and fluid mechanical analysis to various kinds of engines, including those based on Otto, Diesel, Brayton, Rankine, and Stirling cycles. Development of computer models and comparison of cycles in terms of applications to land, marine, and aerospace propulsion. **Prerequisite:** ENGR 124, ENGR 132, ME 175; or MET 140, MET 141, MET 173. **Units:** 3.0.

ME 154. Alternative Energy Systems. Study of alternative energy technologies, such as renewable fuels, wind, solar, oceanic and geothermal power. Concentration on fundamental thermodynamic principles, modern design features and non-technical aspects of each technology. **Prerequisite:** ENGR 124 or MET 140. **Units:** 3.0.

ME 155. Gas Dynamics. Thermodynamics and mechanics of one-dimensional compressible flow; isentropic flow; normal and oblique shock waves; Prandtl-Meyer flow. Combined effects in one-dimensional compressible flow. Nozzles, diffusers and shock tubes. Computer use in gas dynamics. **Prerequisite:** ME 127, ME 175. **Units:** 3.0.

ME 156. Heating and Air Conditioning Systems. Theory and design of heating, ventilating and air conditioning for industrial and comfort applications. Topics include refrigeration cycles, heating and cooling load calculations, psychrometrics, solar heating and cooling component, and system design. **Prerequisite:** ENGR 124, ENGR 132. **Units:** 3.0.

ME 157. Solar Energy Engineering. In-depth study of the basics of solar engineering, including the nature and availability of solar radiation; operation, theory and performance of solar collectors; energy storage and model of solar systems. **Prerequisite:** ME 126; may be taken concurrently. **Units:** 3.0.

ME 159. High Efficiency HVAC. Starts with a review of the theory and design of HVAC systems. Recent improvements and new developments in cooling and heating equipment are studied in detail. Computer models such as the Trane TRACE Program are used to size an HVAC system with an emphasis on high efficiency. Computer based controls and energy management systems are discussed and demonstrated. Field trips to energy efficient installations are included. **Prerequisite:** ME 156 or instructor permission. **Units:** 3.0.

ME 165. Introduction to Robotics. Fundamentals of design and application of industrial robotics. Manipulator kinematics, trajectory planning and controller design, design of end effectors and actuators, sensors, programming languages, and machine vision. Applications in manufacturing, approach to implementing robotics, economic analysis for robotics. Lecture two hours; laboratory three hours. **Prerequisite:** ME 114, ME 115. **Units:** 3.0.

ME 166. Fundamentals of Mechatronics Design. Basic concepts in mechatronics. Foundation to incorporate electronic components, microcontrollers and software in design of mechanical systems. Hands-on experience with components and measurement equipment used in design of mechatronic products. Lecture two hours; laboratory three hours. **Prerequisite:** ME 118 or MET 164, ME 175 or MET 150. **Units:** 3.0.

ME 170. Introduction to Computer Aided Design. Introduction to the digital computer as a tool in engineering design. Study and application of numerical methods to design problems, computer optimization simulation, solid modeling, and computer graphics. Computer aided design analysis and synthesis of components, systems, and structures. A term project is required. Lecture two hours; laboratory three hours. **Prerequisite:** ENGR 6, ENGR 110, ENGR 112, ME 175. **Units:** 3.0.

ME 171. Computer Modeling and Design of Dynamic Systems. Computer modeling and mathematical representation of mechanical, fluid, thermal, and electrical systems. Development of system design criteria and solutions using computer simulation. Use of Bond Graphs and Block Diagram modeling techniques. Study of natural frequencies, eigenvectors, solution of differential equations of dynamic response of computer models. Introduction to start variable feedback control systems. A design project using the computer is required. Lecture three hours. **Prerequisite:** ENGR 110, ME 175. **Units:** 3.0.

ME 173. Applications of Finite Element Analysis. Mathematical fundamentals of Finite Element Modeling (FEA). Engineering analysis and design of structural members, and machinery components using FEA models. Model generation using computer graphics. Computer solutions of static, dynamic, heat transfer, stress analysis, fluid mechanics and structural problems. **Prerequisite:** ENGR 112, ME 175. **Units:** 3.0.

ME 175. Computer Applications in Mechanical Engineering. Computer applications of mechanical engineering problems using micro- and mini-computers. Fundamental concepts of programming in FORTRAN and BASIC, operating system usage. Linear algebra and matrix application; introduction to finite element software. Use of spreadsheets and engineering software application packages. Lecture two hours; laboratory three hours. **Prerequisite:** ME 75 or CSC 15 or CSC 25, and ENGR 17, ENGR 30, ENGR 45. **Units:** 3.0.

ME 176. Product Design and Pro/Engineer. Familiarizes students with digital product development using Pro/ENGINEER and Working Model. Emphasis is on Pro/ENGINEER philosophy of parametric design. Also covers component and assembly design, basic drawing creation, and kinematic simulation using Working Model. Team product design project investigating the effects of variations in geometry, dimensions, and material selection. Lecture two hours; laboratory three hours. **Prerequisite:** ENGR 6, ME 115, ME 175. **Units:** 3.0.

ME 177. Product Design and 3D Parametric Solid Modeling. Introduction to Solid Modeling and its application to mechanical product design. Digital product development using 3D Parametric Solid Modeling tools. Also covers component and assembly design, basic drawing creation. Reverse design project engineering investigating the effects of variations in geometry, dimensions, and material selection. Lecture two hours; laboratory three hours. **Prerequisite:** ENGR 6, ENGR 115, ME 175 (or ENGR 6, MET 164, MET 173 for MET). **Units:** 3.0.

ME 180. Mechanical Properties of Materials. Principles of mechanical properties of metals and polymers, including strength under combined loads, fatigue, and fracture mechanics. Laboratory includes study of strengthening mechanisms, and principles of experimental stress analysis. **Prerequisite:** ENGR 112 and passing score on WPE. **Units:** 4.0.

ME 182. Introduction to Composite Materials. Properties, mechanics, and applications of anisotropic fiber-reinforced materials with an emphasis on the considerations and methods used in the design of composite structures. **Prerequisite:** ME 180. **Units:** 3.0.

ME 184. Corrosion and Wear. Introduction to the phenomena of corrosion and wear, including the electro-mechanical bases of corrosion, examples of corrosion of iron, steel and stainless steels, and prevention of corrosion. Fundamentals of wear are covered including effects of loads, material properties, and lubrication on wear rates. **Prerequisite:** ME 180. **Units:** 3.0.

ME 186. Fracture Mechanics in Engineering Design. Fracture mechanics approach to mechanical design; role of microstructure in fracture toughness and embrittlement; environmentally-induced cracking under monotonic and fatigue loads; laboratory techniques; service failures in various industries and failure mechanisms. **Prerequisite:** ME 180. **Units:** 3.0.

ME 188. Engineering Design with Ceramics. Utilization of ceramic technology in engineering design, including: structures, properties, and processing of ceramics to provide the necessary background for design with ceramic materials; design methodologies; interrelationships of ceramics, metals and polymers; ceramic materials selection; and specific design applications. **Prerequisite:** ME 180. **Units:** 3.0.

ME 190. Project Engineering I. Beginning of a two semester project; design of a product, device, or apparatus that will be fabricated in ME 191. Students work in small groups, interacting with product users, vendors, technicians, and faculty advisors. Lecture two hours; laboratory three hours. **Prerequisite:** ME 115, ME 119, ME 126, ME 138, passing score on WPE; ME 126, ME 138 may be taken concurrently. **Units:** 3.0.

ME 191. Project Engineering II. Continuation of the project begun in ME 190. Part II consists of fabrication and assembly of equipment, testing and evaluation, and reporting. Seminar one hour; laboratory six hours. **Prerequisite:** ME 190. **Units:** 3.0.

ME 194. Career Development in Mechanical Engineering. Designed for Mechanical Engineering students making career decisions. Instruction will include effective career planning strategies and techniques including skill assessment, employment search strategy, goal setting, time management, interview techniques and resume writing. Lecture one hour. **Note:** Units earned can not be used to satisfy major requirements. **Prerequisite:** Senior status. **Graded:** Credit / No Credit. **Units:** 1.0.

ME 195. Professional Practice. Supervised employment in a professional engineering or computer science environment. Placement arranged through the College of Engineering and Computer Science. Requires satisfactory completion of the work assignment and a written report. **Prerequisite:** Instructor permission. **Graded:** Credit / No Credit. **Units:** 1.0-6.0.

ME 196. Experimental Offerings in Mechanical Engineering. When a sufficient number of qualified students apply, one of the staff will conduct a proseminar in some topic of engineering. **Note:** May be repeated for credit with permission of advisor. **Units:** 1.0-4.0.

ME 199. Special Problems. Individual projects or directed reading. **Note:** Open only to students who appear competent to carry on individual work. Admission requires approval of an instructor and the student's advisor. May be repeated for credit. **Graded:** Graded (CR/NC Available). **Units:** 1.0-3.0.

Graduate Courses

ME 206. Stochastic Modeling for Engineers. Fundamentals and applications of stochastic processes for engineers, including a review of engineering statistics, autoregression moving average (ARMA) models, characteristics of ARMA models, ARMA modeling and forecasting, and transformation from discrete models to continuous models. Applications of stochastic processes in engineering field, e.g., precision manufacturing, monitoring and diagnosis of machines, tools, and processes, system identification, vibrations, and statistical process control (SPC). **Prerequisite:** MATH 45 or equivalent. **Units:** 3.0.

ME 209. Research Methodology. Research methodology and engineering approach to problem solving. Includes an orientation to the requirements for Master's thesis in Mechanical Engineering. Students will be exposed to a variety of possible thesis topics. **Prerequisite:** Graduate status in Mechanical Engineering. **Graded:** Credit / No Credit. **Units:** 1.0.

ME 233. Intelligent Product Design and Manufacturing. Application of expert systems, fuzzy logic and neural networks in product design and manufacturing. Concurrent product and process design using expert systems and fuzzy logic. Monitoring tool conditions and manufacturing processes using neural networks so as to achieve high quality, high efficiency, and automation. **Prerequisite:** ME 138, ME 175. **Units:** 3.0.

ME 236. Computer Controlled Manufacturing Processes. Applications of logic and motion controls in manufacturing. Computer controlled open and feedback systems. CNC machining processes, CNC programming. Applications of robots in manufacturing, programming for robots. PLC logic controls, sensors and output devices, creating ladder logic diagrams for the PLCs. Design for Manufacturing (DFM) and Design for Assembly (DFA) of modern computer controlled machines. **Note:** Lectures as well as some tutorial activities are covered in two 75-minute classes per week. **Prerequisite:** ME 138, ME 175. **Units:** 3.0.

ME 237. Digital Control of Manufacturing Processes. Introduction to both the theory and applications of digital control of manufacturing processes, including the discrete controller for manufacturing, digital controlled systems for manufacturing, sensors of control loop for manufacturing, discrete process models for manufacturing, manufacturing system input and response, and stability analysis of manufacturing systems. **Prerequisite:** ME 138, ME 175, MATH 45. **Units:** 3.0.

ME 238. Automated Inspection. Introduction to measurement for machine accuracy and process quality including the use of coordinate measuring machines; system considerations and sensor technology in automated visual inspection; applications of pattern recognition in automated inspection. **Prerequisite:** ME 138, ME 175. **Units:** 3.0.

ME 240. Mechanical Design Analysis. Analyzes mechanical designs with respect to strength or deformation criteria. Elastic and inelastic failure criteria, energy methods, effects of temperature, stress concentrations, and fatigue are discussed. **Prerequisite:** ME 119, ENGR 201; ENGR 201 may be taken concurrently. **Units:** 3.0.

ME 241. Optimum Mechanical Design. Mathematical methods of optimum design using linear and non-linear optimization; constrained and unconstrained optimum design. Optimization of mechanical elements and assemblies to meet design requirements, material characteristics and geometry. Numerical methods and computer usage in optimal design. Application of these principles to realistic design problems. **Prerequisite:** ME 119, ENGR 201; ENGR 201 may be taken concurrently. **Units:** 3.0.

ME 250. Heat Transfer: Conduction. Theory and analytical methods in steady-state and transient heat conduction. Development of the differential equations and initial and boundary conditions. Solutions by separation of variables, transforms, finite differences and integral methods. Heat transfer from extended surfaces. **Prerequisite:** ME 126, ENGR 202; ENGR 202 may be taken concurrently. **Units:** 3.0.

ME 251. Heat Transfer: Convection. Analyzes convective heat and mass transfer. Development of the Navier-Stokes and energy equations for two-dimensional flows. Boundary layer theory and numerical techniques in solving convection problems. Analyzes turbulence, transport by Reynold's stresses and Prandtl's mixing length theory. **Prerequisite:** ME 126, ENGR 201; ENGR 201 may be taken concurrently. **Units:** 3.0.

ME 252. Heat Transfer: Radiation. Fundamentals and basic laws of radiative transfer. Properties of surfaces, spectral characteristics and configuration factors. Radiation transfer between surfaces. Absorbing, emitting and scattering media. Combined conduction, convection and radiation. Applications to solar energy systems. **Prerequisite:** ME 126, ENGR 202. **Units:** 3.0.

ME 253. Advanced Fluid Mechanics. Analytical and numerical analysis of Navier-Stokes equations for laminar flow; stability of laminar flow and its transition to turbulence. Analyzes stream functions and the velocity potential, and vorticity dynamics. The mathematical analysis of incompressible turbulent flows; development of Reynolds stress equations, turbulent boundary layer equations, turbulent flow in pipes and channels, and turbulent jets and wakes. **Prerequisite:** ENGR 132, graduate status. **Units:** 3.0.

ME 256. Mechanics and Thermodynamics of Compressible Flow. Application of the laws of fluid mechanics and thermodynamics to problems of compressible flow in two and three dimensions; small perturbation theory, hodograph method and similarity rules for subsonic flow. Method of characteristics, shock wave analysis for steady, unsteady and supersonic, one-dimensional flows. **Prerequisite:** ME 127, ENGR 201 or ENGR 202; ENGR 201 or ENGR 202 may be taken concurrently. **Units:** 3.0.

ME 258. Advanced Thermodynamics. Advanced topics in thermodynamics including applications of fundamental postulates to chemical, mechanical, magnetic and electric systems, theory of fluctuations, and irreversible thermodynamics. **Prerequisite:** ME 127, ENGR 202. **Units:** 3.0.

ME 259. Introduction to Computational Fluid Dynamics. Fundamentals of computational fluid dynamics, modeling of physical processes, including the fluid flow, heat and mass transfer, and computer skills. Basic concepts of numerical analysis using computer, including the solutions of ordinary and partial differential equations. Basic hands-on experience on using commercial computational fluid dynamics software packages. **Prerequisite:** ENGR 132, ME 126 and ME 175. **Units:** 3.0.

ME 270. Advanced Computer-Aided Design of Dynamic Systems. Computer analysis, synthesis and modeling of physical systems including single and multiple degree of freedom, and linear/nonlinear systems. Use of Computer-Aided Modeling software (CAMP-G) and Advanced Digital Simulation Languages (ADSL). Design and analysis of multi-energy systems using Block Diagrams, Bond Graphs, and state space equation representation. Design of electromagnetic, electro-hydraulic servomechanisms, actuators and driven systems; introduction to multi-variable control of complex systems; stability, controllability, and observability. **Prerequisite:** ME 114, ME 170 or ME 171. **Units:** 3.0.

ME 272. Finite Element Modeling in Computer-Aided Design. Finite-element methods in the analysis and optimal design of machine components, structures, and distributed systems. Generation of FEA models using computers. Theoretical and practical application of a finite element code such as PATRAN to the solution of engineering problems. Topics include static and vibration analysis, stress analysis buckling, normal modes, direct and modal frequency response, transient analysis, and heat transfer. **Prerequisite:** ME 173, ME 175. **Units:** 3.0.

ME 276. Advanced Vibration Theory. Advanced study of mechanical and structural vibrations. Discrete and distributed parameter systems with linear and nonlinear characteristics. Variational principle, Lagrange's equation and finite element method. Matrix equation and eigenvalue problems. Modal analysis and modal testing. Stability and control. Theory developed through physical problems. **Prerequisite:** ME 114, ME 171, or CE 166. **Units:** 3.0.

ME 295. Fieldwork. Supervised employment in industry or government that provides practical work experience. Requires satisfactory completion of the work assignment and a written report. **Note:** Units may not be applied toward meeting the 30-unit requirement of the degree. **Prerequisite:** Permission of Graduate Coordinator or Department Chair. **Graded:** Credit / No Credit. **Units:** 1.0-3.0.

ME 296. Experimental Offerings in Mechanical Engineering. When a sufficient number of qualified students are interested, one of the staff will conduct a seminar on some topic of mechanical engineering. **Note:** May be repeated for credit with permission of advisor. **Units:** 1.0-4.0.

ME 299. Special Problems. Any properly qualified student who wishes to pursue a problem of his/her own choice may do so if the proposed subject is acceptable to the faculty member with whom he/she works and to his/her advisor. **Graded:** Graded (CR/NC Available). **Units:** 1.0-3.0.

ME 500. Master's Thesis/Project. Completion of a thesis or project. Credit given upon successful completion of a Master's Thesis (5 units), or a Master's Project (2 units). **Prerequisite:** Open to students who have advanced to candidacy and have secured approval of a Thesis/Project proposal form. **Graded:** Thesis in Progress. **Units:** 1.0-5.0.