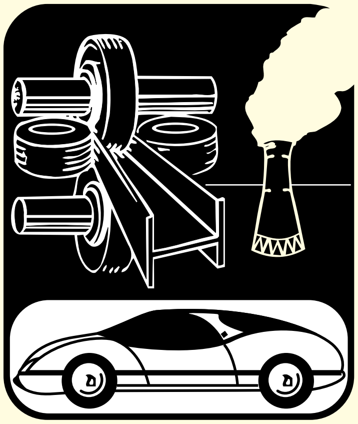
ENGINEERING — MECHANICAL



BACHELOR OF SCIENCE
MASTER OF SCIENCE

PROGRAM DESCRIPTION

Mechanical Engineering is the discipline involved with 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 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.

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.

FACULTY

Ngo Dinh Thinh, *Department Chair*

Robin Bandy; Andrew Banta; James Bergquam; Leo Dabaghian; Trevor Davey; Estelle Eke; Jose Granda; Joseph Harralson; Susan Holl; Tien-I Liu; James Penaluna; Frederick H. Reardon; Frederick Schneider; Ngo Dinh Thinh; Charles Washburn; Tong Zhou

Jessie Richburg, *Department Secretary*
Department Office, ECS-4024, 278-6624

FEATURES

The Mechanical Engineering faculty members have backgrounds in Mechanical, Aeronautical, Manufacturing, and Materials Science engineering. The faculty has a variety of research interests; a majority have industrial experience, which contributes to the applied emphasis in the ME program. Most of the faculty have doctorates; many are registered engineers.

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.

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. The upper division students do cooperative work on team projects and often develop study groups in other courses.

CAREER POSSIBILITIES

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

MAJOR REQUIREMENTS • BS

Total units required for BS: 140
Total units required for Major: 56 plus GE courses
Total units required for Pre-Major: 48 plus GE courses
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.

1. First Semester Freshman Year (17 units)

- (5) CHEM 1A* General Chemistry
- (2) ENGR 4 Descriptive Geometry & CAD
- (4) MATH 30* Calculus I (MATH 29 or equivalent)
- (3) General Education course
- (3) General Education course

2. Second Semester Freshman Year (17 units)

- (4) MATH 31* Calculus II (MATH 30)
- (3) ME 37 Manufacturing Processes
- (4) PHYS 11A* General Physics-Mechanics (MATH 30, 31; MATH 31 may be taken concurrently)
- (3) ENGL 20 Expository Writing (ENGL 1A)
- (3) General Education course

3. First Semester Sophomore Year (17 units)

- (3) ENGR 45 Engineering Materials (PHYS 11A, CHEM 1A)
- (4) MATH 32 Calculus III (MATH 31)
- (4) PHYS 11C* General Physics-Electricity & Magnetism (PHYS 11A, MATH 31)
- (3) General Education course
- (3) General Education course

4. Second Semester Sophomore Year (18 units)

- (2) CSC 16* FORTRAN Programming **OR**
  CSC 17 Introduction to Computer Aided Engineering (MATH 30, PHYS 11A, and ENGR 30; PHYS 11A and ENGR 30 may be taken concurrently)
- (3) ENGR 17 Introductory Circuit Analysis (PHYS 11C, MATH 45; either, but not both, may be taken concurrently)
- (3) MATH 45 Differential Equations for Science & Engineering (MATH 31)
- (3) ENGR 30 Analytic Mechanics: Statics (PHYS 11A, MATH 31, ENGR 4)
- (4) PHYS 11B* General Physics-Heat, Light, Sound (PHYS 11A, MATH 31)
- (3) General Education course

*Course may also satisfy General Education requirements. A second year foreign language course (2A or equivalent) may also satisfy 3 units of GE when the course is being taken to comply with the CSUS 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 not allowed to enroll in upper division Engineering or Mechanical Engineering courses unless all required lower division Pre-Major courses have been satisfactorily completed. Pre-Major students must complete a Change of Major form and submit it to the Mechanical Engineering Department office during the application filing period.

1. First Semester Junior Year (18 units)

- (3) ENGR 110 Analytic Mechanics: Dynamics (ENGR 30, MATH 32, 45)
- (3) ENGR 112 Mechanics of Materials (MATH 45, ENGR 30, 45)
- (3) ENGR 124 Thermodynamics (MATH 32, PHYS 11A)
- (3) ME 118 Product Design I (ENGR 4, 112; ENGR 112 may be taken concurrently)
- (3) ME 175 Computer Applications in Mechanical Engineering (ENGR 17, 30, 45, CSC 16 or 17; ENGR 17 may be taken concurrently)
- (3) General Education course

2. Second Semester Junior Year (18 units)

- (3) ENGR 132 Fluid Mechanics (ENGR 110)
- (3) ME 115 Dynamics of Machinery (ENGR 4, 110, ME 175)
- (3) ME 119 Product Design II (ME 37, 118, 175)
- (2) ME 125 Mechanical Engineering Measurement (ENGR 124, 132, ME 115, 175, Writing Proficiency Exam; ENGR 132 and ME 115 may be taken concurrently)
- (3) ME 127 Intermediate Thermodynamics (ENGR 124, 132, ME 125, 175; ENGR 132 and ME 125 may be taken concurrently)
- (4) ME 180 Mechanical Properties of Materials (ENGR 112)

3. First Semester Senior Year (17 units)

- (2) ENGR 115 Statistics for Engineers (MATH 31; may be taken concurrently)
- (3) ME 114 Vibration & Controls (ENGR 110, ME 175) **OR**
  ME 171 Computer Modeling of Dynamic Systems (ENGR 110, ME 175)
- (3) ME 126 Heat Transfer (ENGR 124, 132, ME 175)
- (3) ME 138 Concurrent Product & Process Design (ME 119 or MET 166; may be taken concurrently)
- (3) ME 190 Project Engineering I (ME 115, 119, 126, 127, 138; ME 126, 127, 138 may be taken concurrently)
- (3) General Education course

4. 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.

Mechanical Engineering Electives

BME 120	Electronic Instrumentation
ME 131	Quality Assurance
ME 136	Numerical Control Programming
ME 137	Product Design for Computer-Aided Manufacturing
ME 141	Design of Internal Combustion Engines
ME 143	Vehicle Design
ME 151	Fundamentals of Combustion
ME 152	Turbomachinery Design
ME 153	Thermodynamics of Combustion Engines
ME 155	Gas Dynamics

ME 156	Heating & Air Conditioning Systems
ME 157	Solar Energy Engineering
ME 159	High Efficiency HVAC
ME 165	Introduction to Robotics
ME 170	Introduction to Computer-Aided Design
ME 171	Computer Modeling & Design of Dynamic Systems
ME 173	Introduction to Finite Element Analysis
ME 182	Introduction to Composite Materials
ME 184	Corrosion & Wear
ME 186	Fracture Mechanics in Engineering Design
ME 188	Engineering Design with Ceramics

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.

Accreditation

The Mechanical Engineering program is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (EAC/ABET). In keeping with this 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.

Courses taken in the Freshman and Sophomore years, either at CSUS, 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. Communications 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 can not 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.

Cooperative Education

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 this program should apply to the Cooperative Education Program office, Engr. 1204.

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 the scientific and technical principles underlying modern engineering practice and of the advanced mathematical techniques needed for their application in research and design.

Each student selects either Design and Manufacturing or Thermal Energy Systems as his/her area of interest. In each area there are specific course requirements to be met. Elective courses allow for the development of the particular interests of each student. An individual applied research or design study, the results of which are presented in a Master's thesis, 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
- (for foreign students only) a TOEFL score of 550 or higher

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 on 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 into the program, although conditional acceptance may be granted before the prerequisites are completed.

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 admission before Computer Access Student Phone Entry Registration (CASPER) deadline. All prospective graduate students, including CSUS graduates, must file the following with the Graduate Center:

- an application for admission and a supplemental application for graduate admission (Forms A and B in the CSU application booklet)
- two sets of official transcripts from all colleges and universities attended other than CSUS
- (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, **and**
- completed at least 12 units in the graduate program with a minimum 3.0 GPA, including at least 9 units at the 200 level, **and**
- obtained approval of a thesis topic using the Department of Mechanical Engineering Master's Thesis Approval Form.

Advancement to Candidacy forms are available in the Graduate Center. 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 Graduate Center for approval.

Degree Requirements

The Master of Science in Mechanical Engineering requires completion of 30 units of study with a minimum grade point average of 3.0.

A. Required Core Courses (9 units)

(3)	ENGR 201	Engineering Analysis I (MATH 45)
(3)	ENGR 202	Engineering Analysis II (MATH 45)
(3)	ME 206	Stochastic Modeling for Engineers (MATH 45 or equivalent)

B. Areas of Study (9 units)

(9) Select at least three courses from one of the two following Areas of Study:

1. Thermal Sciences

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.

Approved Courses

ME 250	Heat Transfer: Conduction
ME 251	Heat Transfer: Convection
ME 252	Heat Transfer: Radiation
ME 253	Advanced Fluid Mechanics
ME 254	Gas Turbine Design
ME 256	Mechanics & Thermodynamics of Compressible Flow
ME 258	Advanced Thermodynamics

2. Design and Manufacturing

This area focuses on the design of products and of the manufacturing systems needed for their production. Classical and computer-based 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 design optimization. The manufacturing part of the curriculum includes the use of mathematical methods as well as current computer techniques to solve problems encountered in planning, designing and/or controlling manufacturing systems.

Approved Courses

ME 233	Product Design & Manufacturing Using Artificial Intelligence
ME 237	Digital Control of Manufacturing Processes
ME 238	Automated Inspection
ME 240	Mechanical Design Analysis
ME 241	Optimum Mechanical Design
ME 270	Advanced Computer Aided Design of Dynamic Systems
ME 272	Finite Element Modeling in Computer Aided Design

C. Electives (6 units)

(6) Select six units of courses, in consultation with a faculty advisor. Upper division undergraduate courses may be used as elective courses. However, no course can be used for both undergraduate and graduate credit.

D. Culminating Requirement (6 units)

(1)	ME 209	Research Methodology
(5)	ME 500	Master's Thesis

Note: A thesis proposal must be approved by the student's advisor before work on the thesis is begun. The proposal must include the signatures of the supervising professor and at least one more faculty member, who serves as the second reader. Upon completion of all coursework, and before the thesis can be submitted to the Dean of Graduate Studies, the thesis must be presented to the faculty.

Advising

The Department of Mechanical Engineering has a Graduate Coordinator who is the liaison between each graduate student and the office of the Dean of Research and Graduate Studies. Upon admission to Mechanical Engineering, every student is assigned an academic advisor to lay out a mutually agreeable course of study for accomplishing the degree objectives. After advancing to candidacy (see above), the student proceeds with research for the thesis. Guidance of this phase of study may be switched to a faculty member with expertise in the particular thesis topic, who becomes the supervising professor for the thesis.

LOWER DIVISION COURSES

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. 3 units.

UPPER DIVISION COURSES

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. **Prerequisites:** ENGR 110, ME 175. 3 units.

115. Dynamics of Machinery. Analysis and synthesis of linkages, cams and gear teeth for displacement, velocity and acceleration. Analysis of applied and inertia forces in machinery; balancing; elements of vibration. Lecture three hours. **Prerequisites:** ENGR 4, 110, ME 175. 3 units.

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. **Prerequisites:** ENGR 4, 112; ENGR 112 may be taken concurrently. 3 units.

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. **Prerequisites:** ME 37, 118, 175. 3 units.

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. **Prerequisites:** ENGR 124, 132, ME 115, 175, Writing Proficiency Exam; ENGR 132 and ME 115 may be taken concurrently. 2 units.

126. Heat Transfer. Basic principles of heat transfer, including processes of conduction, convection, radiation, evaporation and condensation. Lecture two hours, laboratory three hours. **Prerequisites:** ENGR 124, 132, ME 175. 3 units.

127. Intermediate Thermodynamics. Advanced topics in thermodynamics, including compressible flow in ducts and nozzles, reactive systems, homogeneous equilibrium **Prerequisites:** ME 125, 175, ENGR 124, 132; ME 125, ENGR 132 may be taken concurrently. 3 units.

131. Quality Assurance. The organization, economics, and management of quality assurance. Applications to the control of manufactured products, frequency distribution, acceptance sampling plans, and control charts. **Prerequisite:** ME 37. 3 units.

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. **Prerequisites:** ME 37; and ME 175 or MET 173; ME 175 or MET 173 may be taken concurrently. 3 units.

137. Product Design for Computer-Aided Manufacturing. Computer-Aided Manufacturing considerations in product design, rapid prototyping, parts classification and coding, applications of CAD/CAM software in product design and automation, automatic tool path generation and computer-aided process planning. **Prerequisites:** ENGR 4, ME 37, 175. 3 units.

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. **Prerequisites:** ME 119 or MET 166; ME 119 or MET 166 may be taken concurrently. 3 units.

141. Design of Internal Combustion Engines. Introduction to the design methods used in developing modern internal combustion engine. Combines thermodynamics, gas dynamics, combustion, and advanced machine design topics in a study of actual design practice, computer applications and case studies of specific engines. Course includes a broader spectrum of design application other than engines. **Prerequisites:** ME 115, 119, ENGR 124; ME 119 may be taken concurrently. 3 units.

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. **Prerequisites:** ME 119 or MET 166; may be taken concurrently. 3 units.

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; may be taken concurrently. 3 units.

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. **Prerequisites:** ME 127, 175. 3 units.

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. **Prerequisites:** ME 175, ENGR 124, 132; or MET 140, 141, 173. 3 units.

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. **Prerequisites:** ME 127, 175. 3 units.

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. **Prerequisites:** ENGR 124, 132. 3 units.

157. Solar Energy Engineering. An 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. 3 units.

159. High Efficiency HVAC. This course 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. **Prerequisites:** ME 156 or consent of instructor. 3 units.

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. **Prerequisites:** ME 114, 115. 3 units.

170. Introduction to Computer Aided Design. An 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. **Prerequisites:** ENGR 4,110, 112, ME 175. 3 units.

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. **Prerequisites:** ENGR 110, ME 175. 3 units.

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. **Prerequisites:** ME 175, and ME 119 or CE 161; ME 119 may be taken concurrently. 3 units.

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. **Prerequisites:** CSC 16 or 17, ENGR 17, 30, 45; ENGR 17 may be taken concurrently. 3 units.

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. **Prerequisites:** ENGR 112. 4 units.

182. Introduction to Composite Materials. The 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. 3 units.

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. 3 units.

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. 3 units.

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. 3 units.

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. **Prerequisites:** ME 115, 119, 126, 127, 138; ME 126, 127, 138 may be taken concurrently. 3 units.

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. **Prerequisites:** ME 190. 3 units.

195. Fieldwork. Supervised work experience in a specified engineering area. **Prerequisites:** enrollment in the ME major and permission of instructor. 1-6 units.

195A-E. Professional Practice. Supervised employment in a professional engineering or computer science environment. Placement arranged through the School of Engineering and Computer Science. Requires satisfactory completion of the work assignment and a written report. **Prerequisite:** permission of instructor. Graded Credit/No Credit. 1-12 units.

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. May be repeated for credit with permission of advisor. 1-4 units.

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. 1-3 units.

GRADUATE COURSES

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. Not offered every semester. 3 units.

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 standing in Mechanical Engineering. Graded Credit/No Credit. 1 unit.

231. Statistical Quality Control. Design of acceptance sampling plans and control charts. Investigation of sampling attributes using single, sequential, and multiple plans. Acceptance sampling by variable plans, and process control chart design. Evaluation of various quality control techniques for effective economic advantage comparisons. **Prerequisite:** ENGR 115. 3 units.

233. Product Design and Manufacturing Using Artificial Intelligence. Application of artificial intelligence in product design and manufacturing. Concurrent product and process design by using expert systems. Monitoring and sensing the tool conditions and the manufacturing process. **Prerequisites:** ME 37, 175. 3 units.

237. Digital Control of Manufacturing Processes. Software and hardware for digital control of manufacturing processes, including a review of Numerical Control (NC) part programming, digital system devices, interpolators for manufacturing system, digital control loops of NC systems and computerized NC. **Prerequisites:** ME 37, 175, MATH 45. 3 units.

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. **Prerequisites:** ME 27, 175. 3 units.

240. Mechanical Design Analysis. Analysis of 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. **Prerequisites:** ME 119, ENGR 201; ENGR 201 may be taken concurrently. 3 units.

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. **Prerequisites:** ME 119, ENGR 201; ENGR 201 may be taken concurrently. 3 units.

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. **Prerequisites:** ME 126, ENGR 202; ENGR 202 may be taken concurrently. 3 units.

251. Heat Transfer: Convection. Analysis of 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. Analysis of turbulence, transport by Reynold's stresses and Prandtl's mixing length theory. **Prerequisites:** ME 126, ENGR 201; ENGR 201 may be taken concurrently. 3 units.

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. **Prerequisites:** ME 126, ENGR 202. 3 units.

253. Advanced Fluid Mechanics. Analytical and numerical analysis of Navier-Stokes equations for laminar flow; stability of laminar flow and its transition to turbulence. Analysis of 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. **Prerequisites:** ENGR 132, graduate standing. 3 units.

254. Gas Turbine Design. General design features of gas turbines. Thermodynamics and cycle calculations. Axial and centrifugal compressor design and performance. Combustion system design. Axial and radial turbine design and performance. Mechanical design problems including stress, vibration and cooling. Computer-aided design of gas turbines. **Prerequisite:** BSME or permission of instructor. 3 units.

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. **Prerequisites:** ME 127, ENGR 201 or 202; ENGR 201 or 202 may be taken concurrently. 3 units.

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. **Prerequisites:** ME 127, ENGR 202. 3 units.

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. **Prerequisites:** ME 111, 170 or 171. 3 units.

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. **Prerequisites:** ME 173, 175. 3 units.

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. May be repeated for credit with permission of advisor. 1-4 units.

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. 1-3 units.

500. Master's Thesis. Credit given upon successful completion of thesis approved for the master's degree. Should be started early in program to insure adequate completion time. 1-5 units.