administrative, resource and environmental overlays. (Field trips required)

GME 175. GIS Design (3)
Prerequisite: GME 173. Application of data quality, accuracy, ethics and liability issues to the design of integrated Geographic Information Systems; integrated data structure, algorithm, and database considerations; major design team GIS development project required. (Field trips required)

GME 177. GIS Database Design (3)
Prerequisites: GME 135, 173. GIS database structure and design; design, use, maintenance and mutation of comprehensive relational and spatial database structures for GIS applications; structured query language; hardware implications and case studies of existing GIS software packages; creation of new GIS applications software

GME 180. Senior Project (2)
Prerequisites: GME 123, 135, 143, 151, 173; approved subject; IE 182W or Upper Division Writing Exam or concurrently; GME 181 or concurrently. Study of a problem under supervision of a faculty member; final typewritten report required. Individual project except by special permission. GME 180 and GME 181 satisfy the senior major requirement for the B.S. in Geomatics Engineering. (Field trips required)

GME 181. Project Design (3)
Prerequisite: GME 123, 135, 143, 151, 173. Design of control, boundary location, and photogrammetric systems. Evaluation of design requirements, economic, and social considerations. Case Studies. Student presentations. GME 180 and 181 satisfy the senior major requirement for the B.S. in Geomatics Engineering. (Field trips required)

GME 190. Independent Study (1-3; max total 6)
See *Academic Placement — Independent Study.* Approved for ***RP*** grading.

GME 191T. Topics in Geomatics Engineering (1-3; max total 6)
Prerequisite: permission of instructor. Investigation of selected geomatics engineering subjects not in current courses.

GME 193. Internship in Geomatics Engineering (2-4)
Prerequisite: permission of adviser. Engineering practice in a consulting, industrial, professional, or government work setting. A report will be required of the student at the termination of each implemented experience. This course cannot be used to meet graduation requirements. ***CR/NC*** grading only.

Department of Industrial Engineering

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Industrial Engineering Admissions Suspended

As of fall 2004, admissions to the Industrial Engineering program have been suspended. Students with substantial coursework in this area should consult with the Department of Mechanical and Industrial Engineering.

Program Description

Industrial engineering deals with the design, improvement, and installation of integrated systems of people, materials, equipment, and energy. It draws upon specialized knowledge and skill in the mathematical, physical, and social sciences together with the principles and methods of engineering analysis and design to specify, predict, and evaluate the results to be obtained from such systems.

The industrial engineering faculty are committed to providing all students the advanced technology background necessary for success and growth in their selected professions. A program of study is offered to all students through a carefully designed curriculum which includes engineering analyses for the design of man-machine systems, optimization of industrial systems, and the scientific management of engineering activities. Specialized training is available in the use of modern engineering tools and techniques such as computer assisted design (CAD), robotics, computer integrated manufacturing (CIM), quality engineering, and ergonomic (human factors) engineering.

Bachelor of Science Degree Requirements

Industrial Engineering Major *Units*

Major requirements 63
IE 75, 85, 90, 95, 110, 111, 113, 115, 127, 130, 160, 165, 180, 182W ..... (35)
CE 29 or ME 29 ..... (3)
ECE 70, 91, 91L ..... (7)
ME 26, 31, 136 ..... (9)
Select at least one course from each of the following groups ..... (9)
Group A (Quality Engineering Science): IE 112, 120, 170
Group B (Design): IE 145, 148, 155
Group C (Engineering Science): CE 142; ECE 121; ME 116; IE 190, 191T

Other requirements 57
General Education
Select one course from each of the G.E. areas: Area A1, A2, B2, C1, D1, D2, D3. (See pages 89-92 for G.E. listings.)
The following courses are required to satisfy both G.E. and major requirements: MATH 75 [B4], CHEM 1A [B1], PHIL 20 [C2], IE 114 [IB], PHIL 120 [IC], PLSI 120 [M/I]
Additional requirements
MATH 76, 77; PHYS 4A, 4AL, 4B

Total 120

Note: Engineering majors are exempt from G.E. Area A3, third course Area C, Area E, and Area ID.

See the catalog Web Site for recommended program at *http://www.csufresno.edu/catoffice/current/engindrec.html.*

Advising Notes

1. Courses in mathematics, the physical sciences, or engineering taken ***CR/NC*** are not counted toward fulfillment of degree requirements in industrial engineering.
2. Industrial engineering majors might consider a math or business minor.
3. Since the industrial engineering major curriculum is very demanding, many students, especially those not fully prepared in mathematics, chemistry, and/or physics, take $4\frac{1}{2}$ or more years to graduate rather than the traditional four years. Students not fully prepared in chemistry should consider taking CHEM 3A and 1A (lecture only) in lieu of CHEM 1A. If needed, students also may go to the Learning Resource Center in Lab School, Room 137 and request tutorial assistance.

COURSES

Industrial Engineering (IE)

IE 10. Engineering Skills (2)
Provides engineering students with experience in solving problems and presenting solutions in a logical manner, introduces students to subject areas common to most engineering disciplines and develops basic skills for solving problems through an engineering approach. *CR/NC* grading only; not applicable toward baccalaureate degree requirements.

IE 75. Introduction to Industrial Engineering (1)
An overview of the field of industrial engineering. Brief discussion of plant layout, work measurement, engineering economy, quality control, production control, human factors, and operations research. A brief survey of the current status of industrial engineering. (Field trips required)

IE 85. Computer Methods Laboratory (1)
Prerequisite: MATH 75 (may be taken concurrently). Application of existing microcomputer software and the development of new programs to solve frequently encountered problems in engineering practice. Includes Excel, Access, and Visual Basic. (3 lab hours)

IE 90. Manufacturing Processes (3)
Prerequisites: ME 26, 31. Processing techniques, including casting, welding, forming, and machining; capabilities and limitations of these techniques. (2 lecture, 3 lab hours; field trips required)

IE 95. Human Factors in Ergonomics (3)
Introduction to principles of human factors in ergonomics, analysis of information processing, controls and displays, hand tools, physical work, anthropometry, workspace design, and environmental factors to improve quality of life and foster life-long learning. G.E. Breadth E1.

IE 110. Statistical Analysis in Engineering (3)
Prerequisite: MATH 76. Fundamentals of probability and statistics. Applications of statistical methods to engineering problems.

IE 111. Work Measurement (3)
Prerequisite: IE 110 (or concurrently). General approach to the design process; application of design process to problem solving. Methods evaluation techniques; motion and time study, work sampling, and simulation. (2 lecture, 3 lab hours; field trips required)

IE 112. Statistical Design of Experiments (3)
Prerequisites: IE 85, 110. Analysis of variance; regression and correlation; analysis of covariance; randomized blocks and Latin squares; design of experiments; response surface analysis and determination of optimum conditions.

IE 113. Operations Analysis (3)
Prerequisites: IE 85, 110. Application of linear algebra, differential equations, and quantitative and numerical techniques for analysis and optimization of complex operational problems.

IE 114. Facilities Engineering (3)
Prerequisite: IE 90, 111 or permission of instructor. Feasibility study, process planning, material flow system design, materials handling system planning, facilities layout, location of facilities, economic analysis, implementation planning. (2 lecture, 3 lab hours)

IE 115. Quality Control and Reliability Engineering (3)
Prerequisite: IE 110. Fundamentals of statistical quality control and reliability engineering. Sampling plans. Control charts. Reliability techniques.

IE 120. Systems Safety Engineering (3)
Prerequisite: IE 110. Principles of system safety engineering. Selected topics include: human factors engineering, key system interfaces, logic trees, fault and risk tree analyses, hazard identification and analysis, safety review system trees, statistical analysis, product safety.

IE 127. Human Factors Engineering Design Laboratory (1)
Prerequisites: IE 95, 182W (or concurrently). Expands principles developed in the introductory human factors course for use in engineering design. (3 lab hours)

IE 130. Production and Inventory Control (3)
Prerequisite: IE 113 or permission of instructor. Fundamental concepts of production and inventory planning, analysis and control; inventory and production costs; analysis of variations in demands, availability of supplies and optimum production schedules; use of computer simulation techniques; case studies.

IE 145. Design of Automated Systems (3)
Prerequisite: IE 85 or permission of instructor. Study of fundamentals of manufacturing automated systems. Techniques and applications of computer to monitor and control industrial processes. Included topics are characteristics and applications of sensors and actuators, programming considerations, integration of CNC, CAD, CAM, etc. (2 lecture, 3 lab hours; field trips required)

IE 148. Simulation of Industrial Systems (3)
Prerequisite: IE 110. Application of discrete-event simulation techniques for the solution of complex industrial problems; use of various computer simulation languages; review of Monte Carlo processes and digital simulation of continuous processes.

IE 155. Design and Applications of Robotic Systems (3)
Prerequisites: IE 85, 90, senior standing. Introduction to the use of robotics for industrial automation. Components and operation of robot systems; programming of robots; robot implementation and industrial applications of robots. (2 lecture, 3 lab hours)

IE 160. Engineering Economy (2)
Prerequisite: upper-division standing in engineering. Importance of economic analyses of problems in engineering and in management decision making; interest, depreciation, income tax, classification of costs, break-even and minimum cost points, economic comparisons of alternatives, economy of replacement.

IE 165. Computer-Integrated Manufacturing (3)
Prerequisite: IE 145 or permission of instructor. Review the role of computers in manufacturing automation. Evolution and implementation techniques. CIM perspective and integrating technology. Includes CAD/CAM, FMS, robotics, MRPII, MIS, etc. Economic and social impact of CIM. (2 lecture, 3 lab hours)

IE 170. Engineering Management (3)
Prerequisite: junior standing. Study of modern management techniques in engineering. A systems approach to planning and controlling of product/production costing. The computational techniques and the behavioral aspects of management/engineering decision-making are considered.

IE 180. Senior Design Project and Seminar (3)
Prerequisites: senior standing in industrial engineering or permission of instructor; approved subject; IE 182W (or concurrently). A meaningful major design project which focuses on engineering practice and draws on past coursework, under the supervision of a faculty member. Final report and presentation is required, including evaluation of the design requirements, economic, and social considerations. Satisfies the senior major requirement for the B.S. in Industrial Engineering.

IE 182W. Engineering Writing (3)
Prerequisites: satisfactory completion (*C* or better) of the ENGL 1 graduation requirement; junior standing. The use of critical thinking in the engineering problem-solving process and documentation of the process through letters, reports, and engineering specifications. The use of oral technical presentation techniques typical of the engineering practice. Meets the upper-division writing skills requirement for graduation.

IE 190. Independent Study (1-3; max total 6)
See *Academic Placement — Independent Study.* Approved for *RP* grading.

IE 191T. Topics in Industrial Engineering (1-3; max total 6)
Prerequisite: permission of instructor. Investigation of selected industrial engineering subjects not in current courses.

IE 193. Industrial Engineering Cooperative Internship (1-6; max total 12)
Prerequisite: permission of adviser. Engineering practice in an industrial or government installation. Each cooperative internship period usually spans a summer-fall or spring-summer interval. This course cannot be used to meet graduation requirements. *CR/NC* grading only.

Mechanical Engineering

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Program Description

Mechanical engineering is the use of basic science in the design and manufacture of components and systems. This requires the application of physical and mechanical principles in the development of machines, energy conversion systems, materials, and equipment for measurement and control. Knowledge of mathematics, physics, and chemistry lies at the core of this field. Application of this knowledge uses engineering technology — a disciplined way of thinking, modeling, and testing that enables development of new systems despite incomplete information and uncertainty.

The program in mechanical engineering provides basics in design and in thermal and fluid mechanics. All areas include statics, dynamics, materials, fluid mechanics, thermodynamics, and experimental methods. Application areas in design include mechanics of materials, applied mechanics, structural and manufacturing aspects of producing equipment, and vibrations. Application areas in thermal and fluid mechanics focus on energy conversion and include combustion, heat engines, refrigeration, and fluid flow.

Students should consult with their advisers to select the proper courses that emphasize their areas of interest.

Engineer-in-Training and Professional Engineering registration is strongly recommended as a first step in professional lifelong learning.

Mission

Our mission is to provide an educational program that will allow our students to meet or exceed the necessary level of academic preparedness for successful professional employment and for graduate study through continuous improvement in curricula and instruction.

Educational Objectives

1. Provide broad-based curriculum in mechanical and industrial engineering fundamentals.
2. Provide a basis for successful professional careers in fields associated with mechanical and industrial engineering.
3. Provide students with a strong foundation for graduate studies in mechanical and industrial engineering and related fields.
4. Provide students with hands-on experience through projects and laboratory courses.
5. Develop students' understanding of global issues.
6. Promote understanding of ethical and professional responsibilities.
7. Develop students' abilities to communicate effectively both orally and in written form.
8. Promote ability to work effectively in teams.

Co-op Program

The department participates in the Cooperative Education Program which allows the student to gain industrial experience and financial benefits through projects with local companies.

Academic Probation

A minimum GPA of 2.0 must be maintained in all courses taken in the College of Engineering. Students who fail to maintain a 2.0 GPA in courses within their major may be placed on administrative academic probation. Failure to eliminate the grade point deficiency could result in disqualification from the College of Engineering.

Career Opportunities

Rapid technological advances in computers, robotics, and automation, combined with declining enrollments in engineering, have created a substantial demand for mechanical and industrial engineers. High-technology industries want mechanical and industrial engineers because of their technical versatility and adaptability to a broad range of engineering activities. Excellent opportunities exist in aerospace, computers, energy, manufacturing and fabrication, machine and tool design, public transportation, electronics, and a host of other industries.