COLLEGE OF ENGINEERING

Edward C. Hohmann, *Dean*
Carl E. Rathmann, *Associate Dean*
Elhami T. Ibrahim, *Director, Graduate Studies*

Engineering is a dynamic profession which provides the expertise to meet the technical challenges facing the nation. Cal Poly's College of Engineering has a well-earned reputation of helping to meet these challenges by graduating engineers and engineering technologists who are prepared to contribute significantly to industry and who are ready for graduate studies. The emphasis on a strong theoretical background coordinated with early and significant laboratory experiences continues to make the program unique in engineering education. The College of Engineering provides study opportunities to undergraduate and graduate students in seven engineering disciplines, offering programs leading to Bachelor of Science degrees in Aerospace, Chemical, Civil, Electrical, Industrial, Manufacturing, and Mechanical Engineering, and the Bachelor of Science in Engineering Technology. In addition, the graduate division offers individualized programs leading to the degrees Master of Science in Electrical Engineering and Master of Science in Engineering with specializations in each of the engineering disciplines. The program in Agricultural Engineering is administered independently through the College of Agriculture. All of the undergraduate engineering curricula are accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET). The program in Engineering Technology is accredited by the Technology Accreditation Commission of ABET. The programs each require 202 units for the Bachelor of Science degree. The Master of Science degrees require an additional 45 or 46 units.

Each engineering curriculum is designed to give the student both an understanding of the fundamental principles of engineering as an applied science and the practical expertise to apply these principles to actual situations. In keeping with ABET criteria each engineering program incorporates these curricular areas into the educational experience: mathematics and basic sciences; engineering sciences and engineering design; and humanities and social sciences. Practice in all forms of communication is interwoven throughout the curriculum. While communication through mathematics is fundamental to engineering, the ability to clearly express oneself both orally and in writing must accompany the precision of mathematics and engineering drawings.

All of the engineering degree programs require an exceptionally strong aptitude in calculus and physics. Studies in mathematics are required at the undergraduate level through the calculus and differential equations, while the basic science requirement includes courses in physics, chemistry, and biology.

The engineering sciences have their roots in mathematics and the basic sciences, but carry knowledge further toward creative application. These studies provide a bridge between mathematics/basic sciences and engineering practice, and include mechanics, thermodynamics, electrical and electronic circuits, materials science, and transport phenomena.

Engineering design is the methodical procedure by which a system, component, or process is devised to meet a recognized need. It is an open-ended decision-making process in which the basic sciences, mathematics, and engineering sciences are applied through a process of synthesis and analysis to create the desired entity. This component of our curricula is particularly strong at Cal Poly and emphasizes student creativity, development and use of design methodology, formulation of design problem statements and specifications, consideration of alternative solutions, feasibility, and optimality considerations.

Studies in the humanities and social sciences serve not only to meet the objectives of a broad education, but also to meet the requirements of the engineering profession. In the interest of making engineers and technologists fully aware of their social responsibilities and better able to consider related factors in the decision-making process, this portion of the curricula includes coursework in communication skills, history, economics, fine arts, literature, sociology and related electives as part of the university's comprehensive General Education program. Students in all majors are urged to consider the Interdisciplinary General Education (IGE) program as a valuable means of satisfying many of the General Education requirements of the degree. Students participating in this eight quarter sequence have the unique opportunity to become active members of a learning community.

It is important to distinguish between Engineering and Engineering Technology. Engineering Technology is that part of the technological field which requires the application of scientific and engineering knowledge and methods combined with technical skills in support of engineering activities; it lies in the occupational spectrum between the craftsman and the engineer. The engineering technologist is more specialized than the engineer, focusing on a technical specialty within an engineering discipline. Compared to the engineering curricula, there is less emphasis on basic science and mathematics and engineering science and more emphasis on skills and knowledge of existing technology related to design support; production; and equipment selection, modification, and service. Studies for the bachelor's degree in Engineering Technology include coursework in: mathematics and basic sciences; technical sciences, specialties, and electives; and social sciences/humanities and communication.

Unlike the more traditional engineering curricula which initiate engineering coursework in the junior year, Cal Poly's program demands that students take computer programming and engineering orientation courses in the freshmen year, and that mathematics, basic science, and general education courses begin concurrently. Throughout their educational programs students become adept at using both the university's computing facilities and the College's computer aided engineering laboratory facilities as part of their regular coursework. Specific features of the curricula reflect the input of the Industrial Advisory Boards, composed of leaders in local industry as well as selected faculty members. Many of the engineering science and engineering design courses have laboratory components. Study of the ethical issues that confront those in the practice of engineering and the need for professional registration are an important part of the curriculum. In addition, many students pass the Engineer in Training Examination (EIT) before they graduate. As a result of this "learn by doing" environment, graduates of the College continue to be in great demand by industry in southern California, helping Cal Poly fulfill its mission of service to the people of California.

Departments host chapters of national professional societies and/or honor societies appropriate to their disciplines. Honor societies include Tau Beta Pi (engineering), Tau Alpha Pi (technology), Sigma Gamma Tau (aerospace), Omega Chi Epsilon (chemical), Chi Epsilon (civil), Eta Kappa Nu (electrical), Alpha Pi Mu (industrial), and Pi Tau Sigma (mechanical). In addition, chapters of the following cross-disciplinary organizations are active: the Institute of Robotics Engineers; Society of Women Engineers; National Society of Black Engineers; Society of Hispanics in Science and Engineering; and the American Indian Science and Engineering Society.

A Partnership in Engineering Education

Recognizing that the professional education of students is a partnership of faculty, staff, administrators and students, the college has identified the responsibilities and obligations needed for this partnership to succeed. Each student of the college is expected to obtain a personal copy of the college's "Engineering Orientation Handbook" from the student's department office and to be cognizant of the information discussed there. That document is not meant as a substitute for the personal advising of students which can occur only in face-to-face discussions, but it should help promote an understanding of the fundamental operating tenets that an engineering education at Cal Poly Pomona incorporates.

All constituencies of the College of Engineering should know and understand both the academic policies of the college as explained in that document and the academic policies of the University as explained in the University Catalog. In many cases, the policies of the College of Engineering are rather strict interpretations of University policy, in keeping with the high standards which the faculty, students and the engineering profession as a whole expect each of us individually to hold.

Students in the college are expected to bring to this partnership: a willingness to learn and demonstrate their mastery of the subject material, an appropriate attitude regarding the seriousness of their studies, and an appreciation of the value of their education. Throughout their academic careers in the college, they should acquire not only the expertise that can be learned in a classroom, but also an esteem for the profession, a maturity of manner, a respect for colleagues, and a credo to guide both personal and professional behavior. These qualities are what makes a graduate of the Cal Poly Pomona's College of Engineering desirable.

Faculty are expected to bring to the partnership: The experiences of having been students themselves and then having practiced in the profession, acquiring the expertise that only practice can perfect, and an eagerness to enthusiastically share this expertise with students. The faculty are committed to seeing students succeed. Excellence in the teaching/ learning enterprise is the primary goal of the faculty. It is the faculty of the College of Engineering that is primarily responsible for developing and maintaining an environment supportive of learning for each student and for encouraging each student to reach for and achieve the highest goals possible. Faculty members provide academic advising of worth, maintain the announced office hours, teach the stated content of each course and evaluate student performance fairly and consistently.

The College of Engineering expects its students to display the intent and motivation to graduate and to achieve their stated degree objectives as optimally as possible. Operationally, the college has the same goals and offers the most expensive undergraduate curricula in the university as optimally as possible. It is only with the students, faculty and staff working hard together in the partnership, and with mutual respect, that our common goal of excellence in preparation for the engineering profession can be achieved.

Preparation For The Engineering Culture

Professional engineering practice has evolved through a millennia-long technological tradition and, as is true of other professions, now consists of a set of standardized characteristics and modes of behavior; it is a culture in an anthropological sense. This "Engineering Culture" has as its particular responsibility not only the maintenance and development of technical knowledge for the larger society, but also the codes of conduct and practice for the application of that knowledge within the larger society. It has its own language, its own operating principles, its own beliefs and its own ethics, all of which are extensions of those of the larger society. The members of this culture assume the responsibility for the welfare of the larger society in matters technological, and are characterized by their advanced and unique analytical and constructive abilities.

The College of Engineering at California State Polytechnic University, Pomona has as its primary mission the preparation of students for entry into the Engineering Culture. The College recognizes the credo of the professional engineer and, as part thereof, that society's safety and well-being demand that engineering professionals practice their craft with diligence. As educators, the faculty know that professional diligence mirrors personal diligence. Accordingly, the faculty of the College of Engineering, while subscribing to the academic policies of the university, also feel dutybound to expect our students and ourselves to answer to the set of high academic standards corresponding to those of the Engineering Culture.

Hence, for a student within the College of Engineering to successfully complete the curriculum efficiently, with pride and with maturity, the student must not only have mastered technical knowledge and skills, but also must have been diligent in attending to the details of his/her individual progress through the program. The student must satisfy the bureaucratic details of his/her own program in a timely, well-planned manner. The student has the responsibility for his/her own progress and is expected to serve as his/her own primary advocate. Furthermore, an engineering student is expected to be mature enough to accept and to deal with the consequences of his/her own actions and inactions.

Some students who complete their engineering studies discover that their professional interests lie elsewhere and redirect their career objectives. There are numerous examples indicating that an engineering education remains the most excellent preparation for all areas of professional practice because of the analytical and critical reasoning abilities that are instilled and because of the principled behavior that engineering demands. Thus the policies of the College of Engineering are intended to provide a framework for developing appropriate modes of conduct no matter what career a student pursues.

Minority Engineering Program

The Minority Engineering Program (MEP) is an academic community of over 650 American Indian, African American, and Latino students in engineering and computer science interested in achieving at the highest level both academically and professionally. A special three-quarter orientation course (EGR 110, 111, and 112) helps the transition to campus. Members receive priority consideration for the Academic Excellence Workshops. Specially selected faculty advisors help assure the students' successful completion of the regular program of studies. Professional engineers and computer scientists serve as actively involved role models while providing practical information about career opportunities. The MEP Study Center provides a friendly environment in which the students can study together, talk with MEP staff, secure tutorial assistance, and find out about special MEP and club activities, field trips, summer job opportunities and scholarships.

Academic Excellence Workshops

Academic Excellence Workshops, administered through MEP, are supplements to certain foundation courses in chemistry, mathematics, physics, and engineering and are open by invitation only. Participants in MEP and SEES in the College of Science receive priority consideration. The Workshop program promotes technical excellence in the subject area while also developing communications skills and building an academic community under the guidance of a trained facilitator. An invitation to participate should be regarded as an honor and a unique opportunity.

Engineering Interdisciplinary Clinic

The Engineering Interdisciplinary Clinic (EIC) performs fixed-price contract applied research for outside agencies, corporations and utilities. Interdisciplinary teams of students, faculty and company liaisons utilize problem analysis, effective communications and cooperative teamwork to provide quality solutions to actual technical problems faced by the public and private sectors. The EIC is dedicated to providing an innovative capstone experience for the EIC students that integrates theoretical and experiential education in preparation for their engineering careers. The intent of the EIC experience is to enhance the personal, intellectual and professional development of students and faculty while providing quality solutions responsive to the technological needs of industry and society.

Engineering Transfer Credit Policy

The Evaluations Office will no longer automatically give students credit for courses in which they have received a "C-" or less even if those courses articulate with Core or Support Courses for the major. Students must request credit for those courses through the General Academic Petition process. The Evaluations Office will give credit for "C-" (or below) transfer courses only with an approved petition. Specific details about this policy are available from academic advisors and from engineering department offices.

General Education Requirements in the College of Engineering

Because of the high-unit nature of all curricula in the College of Engineering, the pattern of General Education course requirements is different than the "standard" pattern discussed earlier. The following table summarizes the GE requirements for each curriculum in the College of Engineering. Specific details are available from academic advisors and from department offices.

1996-97 General Education Requirements in the College of Engineering

	Area 1	Area 2		Area 3		Area 4	Area 5
ARO	ENG 104 (4) COM 204 (4) ENG 105 (4)	2a. MAT 114 (4) 2b. PHY 131/151L (4) 2c. BIO 110 (3) 2d. MAT 317, 318 (3,3)	3a. Elective* (4) 3b. PHL 201 (4) 3c. UD or LD Elective* (4)	3d. EC 202 (4) 3e. & 3f. SOC/PLS 390 (4)	3g. PSY 201 (4)	PLS 201 (4) HST 202 (4)	ECE 353/355L (3/1) ECE 354/356L (3/1)
CME	Pattern 1 (12) or Pattern 2 (12)	2a. MAT 114 (4) 2b. PHY 131/151L (4) CHM 151L, CHM 152L (1,1) 2c. BIO 110 (3) 2d. CHM 316 (3)	3a. Elective* (4) 3b. Elective* (4) 3c. UD or LD Elective* (4)	3d. EGR 403* (4) 3e. & 3f. SOC/PLS 390 (4)	3g. Elective* (4)	PLS 201 (4) HST 202 (4)	CHM 311,312 (3,3) MTE 4xx (4)
CE	ENG 104 (4) COM 204 (4) CE 361 (4)	2a. MAT 114 (4) 2b. PHY 131/151L (4) PHY 152L, 153L (1,1) 2c. BIO 110 (3) 2d. IME 301 (3) or STA 309 (3)	3a. Elective (4) 3b. Elective (4) 3c. UD or LD Elective (4)	3d. CE 301 (4) 3e. & 3f. SOC/PLS 390 (4)	3g. PSY 201 (4)‡	PLS 201 (4) HST 202 (4)	GSC 321 (4) MHR 318* (4)
ECE	ENG 104 (4) COM 204 (4) ECE 311 (4)	2a. MAT 114 (4) 2b. PHY 131/151L (4) PHY 152L (1) 2c. BIO 110 (3) 2d. ECE 302 (4)	3a. Elective* (4) 3b. Elective* (4) 3c. UD or LD Elective* (4)	3d. EC 201 or EC 202 (4) 3e. & 3f. SOC/PLS 390 (4)	3g. Elective* (4)	PLS 201 (4) HST 202 (4)	EGR 402 (4) EGR 403 (4)
ET	ENG 104 (4) COM 204 (4) COM 216 (4)	2a. MAT 130 (4) 2b. PHY 121/141L (4) PHY 142L, 143L (1,1) 2c. BIO 110 (3) 2d. STA 309 (3)	3a. Elective* (4) 3b. Elective* (4) 3c. UD or LD Elective* (4)	3d. EC 201 or EC 202 (4) 3e. & 3f. SOC/PLS 390 (4)	3g. PSY 201 (4)‡	PLS 201 (4) HST 202 (4)	ETT 305 or ETC 301 (4) EGR 402 or MHR 318* (4)
IE and MFE	ENG 104 (4) COM 204 (4) COM 216 (4)	2a. MAT 114 (4) 2b. PHY 131/151L (4) PHY 152L, 153L (1,1) 2c. BIO 110 (3) 2d. IME 301 (3) or STA 309 (3)	3a. Elective* (4) 3b. Elective* (4) 3c. UD or LD Elective* (4)	3d. EC 201 or EC 202 (4) 3e. & 3f. SOC/PLS 390 (4)	3g. Elective* (4)	PLS 201 (4) HST 202 (4)	EGR 402 (4) EGR 403 (4)
ME	ENG 104 (4) COM 204 (4) ME 231 (4)	2a. MAT 114 (4) 2b. CHM 111/151L (3/1) CHM 152L (1) 2c. BIO 110 (3) 2d. ME 330 (4)	3a. Elective* (4) 3b. Elective* (4) 3c. UD or LD Elective* (4)	3d. EC 201 or EC 202 (4) 3e. & 3f. SOC/PLS 390 (4)	3g. Elective* (4)	PLS 201 (4) HST 202 (4)	EGR 403 (4) ECE 333/383L(4)

- All programs in the College of Engineering are nationally accredited by the Accreditation Board for Engineering and Technology (ABET) and engineering curricula are required to satisfy both ABET national requirements and, concurrently, CSU general education requirements. In order to achieve this, underlined courses double-count in satisfying both major and general education requirements. All course-work can be satisfied through course substitution via a General Academic Petition, or via articulation as appropriate. All non-underlined coursework can, in addition, be satisfied via GE certification from a community college.
- Because of ABET requirements in the life sciences, degree credit for any course other than BIO 110 (Area 2c) requires a General Academic Petition.
- (*) denotes a course that could be used to satisfy the Cal Poly Pomona requirement in American Cultural Perspectives.
- (‡) indicates that PSY 201 is a prerequisite for MHR 318 in Area 5.

COLLEGE OF ENGINEERING MINORS

ENERGY ENGINEERING MINOR

John R. Biddle, Chair
Mechanical Engineering

Paul A. Lord,
Aerospace Engineering

A. George Stoll,
Chemical and Materials Engineering

Donald G. Wells,
Civil Engineering

Alexander E. Koutras,
Electrical and Computer Engineering

John D. O'Neil,
Industrial and Manufacturing Engineering

George F. Engelke,
Mechanical Engineering

The purpose of this minor is to provide students in the programs of the College of Engineering and the Physics department of the College of Science a flexible, interdisciplinary program of study in the emerging and important field of energy engineering. The minor is designed to encourage engineering study and applied research directed toward society's energy needs. The multidisciplinary scope of the minor includes study of all energy sources (fossil, solar, geothermal, nuclear and others), energy conversion and transfer systems, efficient energy utilization (including conservation strategies) and environmental implications.

There is an increasing need for technically qualified and informed graduates in the utilization and development of new sources of energy for society. Currently there are many courses in the various engineering disciplines related to this field. By having these courses offered together in a minor program, the graduate will be able to emphasize this important technical area and be better able to accept meaningful technical positions in energy industries.

Completion of the following courses is required:

Thermodynamics	ME	301	(4)
or Chem. Egr. Thermo. I	CHE	302	(4)
or Thermal Physics	PHY	333	(4)
Energy Management	ME	306	(4)
Alternative Energy Sys.	ME	307	(4)

The remainder of the 24 units required for the minor will be selected from:

Air Pollution Control	ARO	418	(4)
Solid Waste Management	CE	457	(3)
Chem. Egr. Thermo. II	CHE	303	(4)
Pollution Abatement	CHE	432/433L	(3)
Ocean Engineering	EGR	430	(4)
Control Systems Engineering	ECE	309	(4)
Thermodynamics	ME	302	(4)
Solar Thermal Engineering	ME	407	(4)
Nuclear Engineering	ME	408	(4)
Kinetic Theory/Stat. Thermo.	ME	409	(4)
Energy and the Environment	PHY	340	(4)
Adv. Nuclear Physics	PHY	404	(4)
Production Engineering I	MFE	324L	(3)
Production Engineering II	MFE	325L	(3)
Eng. Econ. Dec. Anl.	IE	401	(4)
Industrial Engineering Design	IE	429L	(4)
Industrial Engineering Sys.	IE	437	(3)

ILLUMINATION ENGINEERING MINOR

David L. Clark, Chair Electrical and Computer Engineering
Kamran Abedini, Industrial and Manufacturing Engineering
George F. Engelke, Mechanical Engineering

The purpose of the minor in Illumination Engineering is to help meet the need for advanced lighting expertise in the state of California. Because the energy utilized in lighting applications is a significant fraction of the total energy consumption in the state, this minor is intended to help provide the technical basis for lighting applications so that they employ energy-efficient technologies and designs. The major is designed to be appropriate for students in the physical sciences and engineering and engineering technology.

Completion of one course from each of Areas I through IV and two courses from Area V is required with a minimum unit requirement of 24 units.

AREA I (Human Factors)			
Fundamentals of Human Factors Engineering/Laboratory	IE	225/225L	(3/1)
AREA II (Optics/Light)			
General Physics/Laboratory	PHY	234/254L	(3/1)
Applied Optics	PHY	334	(4)
AREA III (Energy Conservation)			
Energy Management	ME	306	(4)
Applied Heating & Air Conditioning	ETM	334	(4)
AREA IV (Lighting Design)			
Interior Design II	HE	320/320A	(3/3)
Stage Lighting	TH	332/332L	(2/1)
AREA V (Lighting Technology)			
Illumination Engineering (required)	ECE	490/490L	(4/1)
Lamp Design/Manufacture	MTE	490/490L	(4)
Lighting Controls/Design	ECE	492	(4)
Luminaries Design/Manufacture	IE	490/490L	(3/1)

MATERIALS SCIENCE AND ENGINEERING MINOR

Julie M. Schoenung, *Chair*
Chemical and Materials Engineering
William E. Mortensen,
Aerospace Engineering
Ronald L. Carlyle,
Civil Engineering
John Palmer,
Electrical and Computer Engineering
John D. O'Neil,
Industrial and Manufacturing Engineering
Hassan M. Rejali,
Mechanical Engineering

Materials Science and Engineering is the discipline that is concerned with studying the relationships among the properties and performance of materials to their structures. The College of Engineering provides a minor in Materials Science and Engineering to the student who satisfactorily completes the 24-unit requirement within his/her major curriculum. The minor is appropriate for all engineering and science majors.

The goal of the materials scientist is to understand and improve the properties of materials while that of the materials engineer is to apply this knowledge in the production, selection and utilization of materials. Since engineers or scientists are called upon to work with new ideas and materials, the broadly trained graduate has an ability to respond to such a challenge.

Students pursuing this minor are particularly encouraged to become active in the student chapters of ASM International and SAMPE.

Completion of the following courses is required:

Materials Science and Engr	MTE	207	(3)
or Engineering Matls.	ME	225	(4)
Materials Sci and Engr Lab	MTE	317L	(1)
or Matls Science and Selection Lab	ME	350L	(1)
Strength of Materials	ME	218	(3)
or Aero Struct Mech	ARO	326	(4)
Three MTE 4xx courses			(12)

The remainder of the 24 units required for the minor will be selected from:

Aero Struct Mech	ARO	327	(3)
Mech of Composite Materials	ARO	436	(4)
Structural Design-Steel	CE	406	(4)
Organic Chemistry	CHM	315	(3)
Organic Chemistry	CHM	316	(3)
Polymer Chemistry	CHM	409	(3)
Intro Colloid & Surface Chem	CHM	413	(3)
X-Ray Methods of Analysis	CHM	442	(4)
Corrosion Chemistry	CHM	446	(4)
Solid State Electronics	ECE	412	(4)
Integrated Circuit Design	ECE	418	(4)
Molding and Casting	IME	134/L	(2)
Mfg. Processes-I	MFE	221/L	(4)
Strength of Materials	ME	219	(3)
Welding Fabrication & Design	MTE	337L	(3)
Adv Science of Materials	MTE	404	(4)
Phys Metallurgy-Mech. Properties	MTE	405	(4)
Phys Metallurgy-Solid & Strength	MTE	406/416L	(4)
Ceramic Materials	MTE	407	(4)
Intro Composite Materials	MTE	408/418L	(4)
Solid State Physics	PHY	406	(4)
Special Topics	MTE	499	(4)

OCEAN ENGINEERING MINOR

George F. Engelke, *Chair,* Mechanical Engineering
Christopher L. Caenepeel, Chemical and Materials Engineering
Donald G. Wells, Civil Engineering
Dennis Fitzgerald, Electrical and Computer Engineering

Ocean Engineering is a cross-disciplinary field dealing with all aspects of the marine environment. Subjects emphasized include marine structures, marine vehicles, marine chemistry, marine ecology, coastal and marine engineering. The Ocean Engineering minor has access to the research facilities of the CSU Ocean Studies Institute (OSI) and the 80' Research Vessel YELLOWFIN. Cal Poly facilities include a fleet of general purpose and instrumented craft, a circular tow tank, wave tank, and the Fluids Laboratory.

The minor in Ocean Engineering is available to any engineering student. Some engineering majors may be able to acquire much of this minor within the framework of their normal degree requirements through careful substitution of certain requirements.

The attainment of a minor in Ocean Engineering is accomplished by appropriate selection, timely scheduling, and satisfactory completion of certain required and elective-type courses, totaling a minimum of 24 units, as outlined below:

Completion of the following courses is required:

Intro to Ocean Engineering	EGR	230	(2)
Ocean Electronics	ECE	434	(4)
Ocean Engineering	EGR	430	(4)
Oceanography	GSC	335	(4)
Intro Marine Biology	BIO	220	(4)
or Marine Ecology	BIO	442	(5)

The remainder of the 24 units required for the minor will be selected from:

Coastal Engineering	CE	455	(4)
Underwater Sound	EGR	437	(4)
Special Problems for UD Students	EGR	400	(1-2)
Special Topics	EGR	499	(1-4)
Corrosion Chemistry	CHM	446	(4)
Coastal Processes	GSC	338	(4)
Welding Fab. & Design	MTE	337	(3)
Skin & Scuba Diving	PE	231	(3)

Departments, Majors, Minors, and Degrees

GRADUATE STUDIES

Elhami T. Ibrahim, Director, Master of Science in Engineering, Master of Science in Electrical Engineering

AEROSPACE ENGINEERING

Paul Lord, Chair, Bachelor of Science in Aerospace Engineering

AGRICULTURAL ENGINEERING

Eudell Vis, Chair, Bachelor of Science in Agricultural Engineering

This engineering program is listed under the College of Agriculture.

CHEMICAL AND MATERIALS ENGINEERING

Julie M. Schoenung, Chair, Bachelor of Science in Chemical Engineering

CIVIL ENGINEERING

Ronald L. Carlyle, Chair, Bachelor of Science in Civil Engineering

Options in General Civil Engineering, Environmental Engineering, and in Surveying Engineering

ELECTRICAL AND COMPUTER ENGINEERING

Richard H. Cockrum, Chair, Bachelor of Science in Electrical Engineering

Options in Computer Engineering, Electrical Engineering and in Electronic Engineering

ENGINEERING TECHNOLOGY

_____, Chair, Bachelor of Science in Engineering Technology, Bachelor of Science in Construction Engineering Technology, and Bachelor of Science in Electronics and Computer Engineering Technology.

INDUSTRIAL AND MANUFACTURING ENGINEERING

Phillip R. Rosenkrantz, Chair, Bachelor of Science in Industrial Engineering, Bachelor of Science in Manufacturing Engineering

MECHANICAL ENGINEERING

George F. Engelke, Chair, Bachelor of Science in Mechanical Engineering

Options in Mechanical Engineering, Energy Systems Engineering and in Petroleum Engineering

ENERGY ENGINEERING MINOR

John R. Biddle, Chair, Energy Engineering Committee

ILLUMINATION ENGINEERING MINOR

David L. Clark, Chair, Illumination Engineering Committee

MATERIALS SCIENCE AND ENGINEERING MINOR

Julie M. Schoenung, Chair, Materials Science and Engineering Committee

OCEAN ENGINEERING MINOR

George F. Engelke, Chair, Ocean Engineering Committee

College of Engineering Courses

All students in engineering and engineering technology curricula must satisfy ENG 104 prior to enrolling in any 300-level or higher course in the College of Engineering.

All EGR 500- and 600-level courses are listed in the graduate section of this catalog.

EGR 101L Laboratory Safety Orientation (1) (CR/NC)

Individualized introduction to the laboratories and shops of the College of Engineering and to the use and care of the equipment. Discussions and demonstrations of responsible and safe conduct. Discussion of fasteners, pipe and tube fittings, and electrical wiring. Safety test must be passed prior to credit being awarded. Credit is not applicable to a degree in the College of Engineering. 3 hours laboratory.

EGR 102L Laboratory Practices and Procedures (2) (CR/NC)

Instruction tailored to the needs of the individual student and includes safe practices and procedures. Intended for students requiring mechanical skills not acquired through the standard curricula. Projects require the use of laboratory and/or shop facilities. Credit is not applicable to a degree in the College of Engineering. Prerequisite: EGR 101/101L or consent of the instructor. 3 hours laboratory.

EGR 110 Engineering Orientation (3)

Introduction to the resources of the College of Engineering; the expectations of the departments and the college; elementary problem-solving, including dimensional analysis; time management and study techniques required by technical majors. The first of a three-course sequence. Open only to students in the Minority Engineering Program. 3 lecture/problems.

EGR 111/111A Engineering Career Exploration (1/1)

Introduction to the fields and career opportunities in engineering and computer science; expectations of first professional position; resume writing and interviewing techniques. Development of different engineering projects; building, testing, evaluating, and making presentations on results. The second of a three course sequence. Open only to students in the Minority Engineering Program. 1 hour lecture, 1 two-hour activity.

EGR 112 Engineering Career Exploration II (1)

Introduction to the work environment in engineering and computer science; site visits. The third of a three-course sequence. Open only to students in the Minority Engineering Program. 1 lecture/problem.

EGR 120 Introduction to Engineering (4)

Role of engineers in society; career opportunities in engineering; use of mathematics and the physical sciences to solve engineering problems; the design process; use of computers in engineering applications. 4 lecture/discussions. Prerequisite: High school course in College Algebra.

EGR 200 Special Problems for Lower Division Students (1-2)

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

EGR 230 Introduction to Ocean Engineering (2)

Instruction in boat safety, nautical Rules of the Road, coastal navigation, and boat handling; operation in coastal ocean waters using Cal Poly's trailerable boats with 3D sonar systems and other equipment. 2 lecture/problems. Prerequisite: Consent of the instructor.

EGR 299/299A/299L Special Topics for Lower Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Consent of instructor. Instruction is by lecture, laboratory, or a combination of both.

EGR 301 The Search for Solutions (4)

A study of the development of society using technology as the prime indicator of the maturing of civilizations. Expansion of the theme that technology has been and continues to be central to society's advances, satisfying life-support demands, and allowing the arts to develop. Discussion of the growth of technology and factors guiding its future growth. 4 lecture/discussions. Prerequisites: completion of General Education Area 2a, b, and c requirements.

EGR 400 Special Problems for Upper Division Students (1-2)

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

EGR 402 Ethics and Engineering Decision-Making (4)

Team taught. Explores the ethics of engineers: values; ethical theory and practice; moral reasoning; morality in law and codes; professional standards and societies. Case studies. Open only to engineering majors, others as space permits with the consent of the instructors. 4 lecture/discussions. Prerequisites: Senior standing and satisfaction of the GWT.

EGR 403 Capital Allocation Theory (4)

Economic theory of capital budgeting decisions. Current and relevant views of engineering economists used to present a unified theory of capital allocation appropriate to private, public and governmental entities. Quantitative analytical methods in formulating business decision models. Integrated application of economic and operations analysis to managerial problem-solving and decision-making processes. Study of effects of inflation and tax consequences on economic decisions. Four 1-hour lecture-discussions. Pre-requisites: EC 201 or EC 202, or consent of instructor, at least junior standing.

EGR 430 Ocean Engineering (4)

The engineering major is acquainted with the wide variety of physical and other factors involved when carrying out engineering tasks associated with the marine environment. Working cruises are made in the 80 foot R/V YELLOWFIN. Topics covered include: ocean and harbor wave actions; ocean basins, currents, and tides; ocean chemistry and physical characteristics; marine biology and fouling; wave and wind loads; ocean energy sources; deep ocean mining and drilling; navy ship systems, surface craft, remotely operated vehicles; marine corrosion, preservation; icing, thermal factors; shock, vibration; human factors; engineering requirements and documentation. 4 lecture/problems. Prerequisite: Upper division standing in the College of Engineering or consent of the instructor.

EGR 437 Underwater Sound (4)

Principles of underwater sound propagation and reception. The sonar equation. Transducer design and calibration. 4 lecture/problems. Prerequisite: Upper division standing and permission of the instructor.

EGR/SCI 460 Problems in Oceanographic Studies (3-5)

Course offered in conjunction with the CSU Ocean Studies Institute (OSI). Topics vary each term. May be repeated as needed. Upper division standing and permission of instructor required.

EGR 461, 462, 463 Engineering Interdisciplinary Clinic I, II, III (3), (3), (3)

Collaborative efforts among the College of Engineering and external clients. Interdisciplinary teams of students, faculty, consultants, and client liaisons develop a project plan that must be implemented. Project results are reported to clients in formal and written reports. Credit for the entire sequence EGR 461, 462, and 463 substitutes for senior project and seminar. Prerequisites: Consent of both the EIC director and the student's department chair.

EGR 470, 471, 472, 473 Cooperative Education (2-4 each)

Four quarters of full-time industry work experience of a nature that relates academic engineering theory to practice. Prerequisite: Junior standing and approval of department co-op coordinator.

EGR 499/499A/499L Special Topics for Upper Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: permission of instructor. Instruction is by lecture, laboratory or a combination of both.

AEROSPACE ENGINEERING

Paul A. Lord, *Chair*
Ali R. Ahmadi
Gabriel G. Georgiades
Robert F. Davey
William E. Mortensen

Traditionally the aerospace engineer has been involved with the design and development of high speed vehicles such as aircraft, missiles and spacecraft. In recent years this list has evolved to include ocean vessels and high speed land vehicles as well. The extreme environments in which these vehicles operate have dictated the construction of the most complex engineering systems devised by man and require integration and application of such disparate fields as fluid mechanics and thermodynamics, structural mechanics, control system theory and vehicle dynamics. Often the aerospace engineer is confronted with problems which cannot be fully defined but, in spite of this, which require imaginative and sophisticated solutions.

This accredited program provides a broad background in the humanities and social sciences, mathematics, basic science, engineering science, analysis, design and systems. The basic concepts taught in these areas are illustrated and reinforced by applications taken from current industrial practice. The advanced engineering (applied mechanics, computer applications, systems analysis) techniques which have been pioneered by the aerospace industry are a mainstay of the program. Facilities available for experimental studies include subsonic and supersonic wind tunnels, environment simulation equipment, and a flight structures laboratory.

Students desiring to major in Aerospace Engineering should have a particularly high aptitude for science and mathematics, and incoming freshmen should have taken substantial college preparatory courses in these disciplines in high school. Incoming transfer students should have completed at least one year of college calculus and one year of college physics (with laboratory) prior to beginning the program at Cal Poly. The community college student planning to transfer into this department should consult a school counselor or his department to determine which courses meet the program requirements.

Graduates of the program are prepared to do productive work in their first job as well as to grow with their profession throughout their engineering career. The curriculum is designed to prepare a student for direct entry into the engineering profession and for graduate school.

Aerospace engineering students are encouraged to become active in the student branch of the American Institute of Aeronautics and Astronautics, a national society organized for the advancement of aerospace knowledge. Qualified students are invited to join the student chapter of Sigma Gamma Tau, the aerospace engineering honor society.

CORE COURSES FOR MAJOR *

(Required of all students)

Intro Aero Engg I	ARO	101L	(1)
Intro Aero Engg II	ARO	102L	(1)
Intro Aero Engg III	ARO	103L	(1)
Fund Systems Engg	ARO	201L	(1)
Fund Aeronautics	ARO	202L	(1)
Fund Astronautics	ARO	203L	(1)
Fluid Mechanics	ARO	301	(4)
Subsonic Aerodynamics	ARO	305	(4)
Astronautics	ARO	309	(3)
Gas Dynamics	ARO	311	(3)
Aerospace Propulsion Systems	ARO	312	(4)
Aerospace Feedback Control Systems	ARO	322	(4)
Intro to Structural Mech	ARO	326	(4)
Aerospace Structural Mech	ARO	327	(3)
Aerospace Structural Analysis and Design	ARO	329	(3)
Fluid Mechanics/Heat Transfer Lab	ARO	351L	(1)
Aerodynamics and Propulsion Lab	ARO	352L	(1)
Aerospace Structures Laboratory	ARO	357L	(1)
Heat, Mass & Moment Trans	ARO	401	(4)
High-Speed Aerodynamics	ARO	404	(3)
Aerovehicle Stab & Control	ARO	405	(4)
Dynamics of Aerospace Systems	ARO	406	(4)
Senior Project	ARO	461	(2)
Senior Project	ARO	462	(2)
Intro to Vehicle Design	ARO	491	(3)
Vehicle Design I Lab	ARO	492L	(2)
Vehicle Design II Lab	ARO	493L	(2)
Vector Statics	ME	214	(3)
Vector Dynamics	ME	215	(4)
Thermodynamics	ME	301	(4)
Advisor Approved Electives			(16)

SUPPORT AND ELECTIVE COURSES

(Required of all students)

General Chemistry	CHM	111/151L	(4)
General Chemistry	CHM	112/152L	(4)
Engineering Design Graphics	MFE	121L	(2)
An Geom Calculus II	MAT	115	(4)
An Geom/Calculus III	MAT	116	(4)
Calc of Several Variables	MAT	214	(3)
Calc of Several Variables	MAT	215	(3)
Diff Eqn	MAT	216	(4)
Materials Science	MTE	207	(3)
General Physics	PHY	132	(3)
General Physics	PHY	133	(3)
General Physics Laboratory	PHY	152L	(1)
General Physics Laboratory	PHY	153L	(1)

GENERAL EDUCATION COURSES

An alternate pattern from that listed here for partial fulfillment of Areas 1, 3, and 4 available for students in this major is the Interdisciplinary General Education (IGE) Program. Please see the description of IGE elsewhere in this catalog.

Area 1:

Freshman English I	ENG	104	(4)
Freshman English II	ENG	105	(4)
Advocacy and Argument	COM	204	(4)

Area 2:

Analytical Geom & Calc	MAT	114	(4)
Laplace Tran & Fourier Series	MAT	317	(3)
Math Analysis of Engr Problems	MAT	318	(3)
Life Science	BIO	110	(3)
General Physics	PHY	131/151L	(4)

Area 3:

Area 3A Elective+			(4)
Introduction to Philosophy	PHL	201	(4)
Area 3C Elective+			(4)
Prin. of Economics	EC	202	(4)
* Political Sociology	SOC/PLS	390	(4)
General Psychology	PSY	201	(4)

Area 4:

Intro to American Government	PLS	201	(4)
U.S. History	HST	202	(4)

Area 5:

Computer Electronics I	ECE	353/355L	(4)
Computer Electronics II	ECE	354/356L	(4)

*Course counted in multiple categories

+One course of these indicated must satisfy the American Cultural Perspectives requirement.

All underlined courses satisfy both major and GE requirements.

* A 2.0 cumulative GPA is required in core courses including option courses for the major in order to receive a degree in the major.

Course Descriptions

All students in engineering and engineering technology curricula must satisfy ENG 104 prior to enrolling in any 300-level or higher course in the College of Engineering.

ARO 101L Introduction to Aerospace Engineering I (1)

Aircraft theme. History of aircraft development; characteristics of current aircraft. Contributions of aerospace engineering to society. Generation of lift. Stress in aircraft structures. Preliminary aircraft sizing. 1 three-hour laboratory. Corequisite: MAT 114 or mathematics course preliminary to MAT 114.

ARO 102L Introduction to Aerospace Engineering II (1)

Spacecraft theme. History of spacecraft development; characteristics of current spacecraft. The role of the aerospace engineer in industry, government and the university. Trajectories and orbits. Spacecraft structures and materials. Satellite configuration. 1 three-hour laboratory. Corequisite: MAT 114 or mathematics course preliminary to MAT 114.

ARO 103L Introduction to Aerospace Engineering III (1)

Propulsion theme. History of aircraft engine and rocket development; characteristics of current aircraft and rocket engines. Ethical factors, standards and expectations in aerospace engineering. Generation of thrust. Structure of propulsion systems. Materials for propulsion systems. Propulsion system performance. 1 three-hour laboratory. Corequisites: MAT 114 or mathematics course preliminary to MAT 114.

ARO 201L Fundamentals of Systems Engineering (1)

History and purpose of systems engineering. Needs analysis; consideration of social, economic and environmental factors. System-design process. Role of the engineer is system design. Program planning and control. Engineering documentation. System-design exercise. 1 three-hour laboratory. Prerequisites: MAT 116, PHY 132/152L. Corequisite: PHY 133/153L.

ARO 202L Fundamentals of Aeronautics (1)

Aircraft manufacturing methods. Aerodynamic drag. Aircraft controls and piloting techniques. Aircraft performance. Aeroelasticity concepts. Preliminary aircraft structural design. 1 three-hour laboratory. Prerequisite: ARO 101L. Corequisite: MAT 115.

ARO 203L Fundamentals of Astronautics (1)

Spacecraft manufacturing methods. Spacecraft mission analysis. Spacecraft guidance and control techniques. Booster design. Boost and reentry trajectory simulation. Problems of hypersonic flight. 1 three-hour laboratory. Prerequisite: ARO 102L. Corequisite: MAT 116.

ARO 299/299A/299L Special Topics for Lower Division Students (1–4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: permission of instructor. Instruction is by lecture/problems, laboratory, or a combination of both.

ARO 301 Fluid Mechanics (4)

Properties of the continuum. Control volume and control surface concepts. Inertial and noninertial systems. Potential flow theory. Development and application of the Navier-Stokes equations. Boundary layer theory. 4 lecture/problems. Prerequisites: MAT 216, ME 215. Corequisite: MAT 318.

ARO 305 Subsonic Aerodynamics (4)

Chordwise and spanwise wing loading. Pressure, induced skin friction drag. Drag polars. Blade element theory. Helicopter rotor aerodynamics. Fuselage aerodynamics. Performance (energy methods); steady flight, accelerated flight, take-off and landing. 4 lecture/problems. Prerequisite: ARO 301.

ARO 309 Astronautics (3)

Space Environment. Mission design environment. Propulsion. Spacecraft attitude control. Thermal control. Configuration and structural design of space vehicles. 3 lecture/problems. Prerequisite: ME 215.

ARO 311 Gas Dynamics (3)

Thermodynamic processes. One-dimensional flow, area change, friction heat addition. Normal and oblique shock waves. Nozzle and diffuser theory. Introduction to quantum physics; Boltzmam distribution; microscopic description of gases; microstates; partition function; properties of high temperature gases. Three lecture/problems. Prerequisite: ARO 301.

ARO 312 Aerospace Propulsion Systems (4)

Systems analysis of the fuel burning performance of aircraft powerplants. Aerothermodynamics of inlets, combustors and nozzles. Cycle analysis. Turbomachines. Emphasis on turboprop, turbojet, turbofan, and ramjet. 4 lecture/problems. Prerequisite: ARO 311.

ARO 322 Aerospace Feedback Control Systems (4)

Mathematical models of systems. Feedback control systems: characteristics, performance, stability. Root locus method. Frequency response methods. Stability in the frequency domain. Time domain analysis. Design and compensation of aerospace feedback control systems. 4 lecture/problem-solving sessions. Prerequisite: MAT 317.

ARO 326 Introduction to Structural Mechanics (4)

Vector statics for equilibrium. Engineering material properties, elasticity, environmental effects. Uniaxial, two- and three-dimensional states of stress and strain. Shear and moment diagrams, beam flexural and shear stresses. 4 lecture/problems. Prerequisites: ME 214, MAT 116.

ARO 327 Aerospace Structural Mechanics (3)

Flexural loading, elastic curve deflections, statically indeterminate beams, plastic analysis, theories of failure fatigue design, column and instability theory. Applications to aerospace structures. 3 lecture/problems. Prerequisite: ARO 326.

ARO 328 Aerospace Structures (4)

Aerospace structural analysis in the design process. Semi-monocoque structures. Energy methods in structural analysis. 4 lecture/problems. Prerequisite: ARO 327.

ARO 329 Aerospace Structural Analysis and Design (3)

Work and energy methods. Numerical analysis and introduction to the finite element method. Thin plate theory and structural stability. Elastic and aeroelastic instabilities. Design of Aerospace structures. 3 lecture/problems. Prerequisite: ARO 327.

ARO 351L Fluid Mechanics and Heat Transfer Laboratory (1)

Selected experiments concerning the fundamentals of incompressible fluid mechanics and conduction, convection, and radiation heat transfer. 1 three-hour laboratory. Prerequisites: ARO 301, 305. Corequisite: ARO 401.

ARO 352L Aerodynamics and Propulsion Laboratory (1)

Selected experiments in low-speed aerodynamics, gas dynamics, high-speed aerodynamics and propulsion using subsonic and supersonic wind tunnels. 1 three-hour laboratory. Prerequisites: ARO 305, ARO 311. Corequisite: ARO 312, ARO 404.

ARO 357L Aerospace Structures Laboratory (1)

Experimental stress analysis, strain gages and photoelasticity. 1 three-hour laboratory. Prerequisite: ARO 327.

ARO 400 Special Problems for Upper Division Students (1-2)

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

ARO 401 Heat, Mass and Momentum Transfer (4)

Transport properties. Transfer of momentum and energy in laminar and turbulent boundary layers. Energy transfer by conduction, convection and radiation. Heat exchangers. Solar radiation. Mass transfer, molecular diffusion. 4 lecture/problems. Prerequisite: ARO 301.

ARO 402 Numerical Methods (4)

Numerical methods in engineering. Algorithms. Interpolating polynomials, difference formulas, numerical differentiation and integration. Matrix methods. Non-linear systems. Solution of differential equations. Applications to engineering problems. 4 lecture/problems. Prerequisite: MAT 216, working knowledge of high-level computer language.

ARO 404 High-Speed Aerodynamics (3)

Effects of compressibility; two-dimensional and conical supersonic flow fields; similarity concepts; solution of wave equations; shock expansion theory. 3 lecture/problems. Prerequisite: ARO 311.

ARO 405 Aerospace Vehicle Stability and Control (4)

Airplane equations of motion. Stability derivatives. Static Stability. Airplane controls. Dynamic stability. Transfer functions. Airplane response and simulation. Flying qualities. 4 lecture/problems. Prerequisites: ARO 305, 322.

ARO 406 Dynamics of Aerospace Systems (4)

Three-dimensional vector dynamics of aerospace systems; linear and angular momentum; Lagrangian dynamics; method of Euler; introduction to space vehicle motion. 4 lectures. Prerequisites: ME 215, MAT 318.

ARO 407 Flight Dynamics (4)

Three dimensional rigid body motion methods of Newton and Lagrange. Euler transformations. Performance analysis of aircraft, missiles and spacecraft. 4 lecture/problems. Prerequisites: ARO 305, 406, MAT 317.

ARO 408 Introductory Finite Element Structures (4)

Matrix operations. Stiffness and flexibility methods. Finite element properties. Computer applications. Structural dynamics. 4 lecture/problems. Prerequisite: ARO 327.

ARO 409 Astrodynamics (4)

Space environment. Kepler's laws of motion and satellite orbits, orbital transfers. Space vehicle motion, de-spinning of satellites. Performance and optimization of single and multistage rocket. 4 lecture/problems. Prerequisite: ARO 406.

ARO 412 Basic Wing Theory (4)

Potential flow theory. Complex mappings; Kutta-Joukowski transformation. Chordwise pressure distributions; thin airfoil theory. Sectional force and moment coefficients. Symmetric and asymmetric spanwise loading; basic and additional lift effects. Twist. Wing force and moment coefficients. High lift devices. 4 lecture/problems. Prerequisite: ARO 305.

ARO 414 Rocket Propulsion Systems (4)

Principles of rocket propulsion. Combustion chemistry. Liquid-fuel rocket engines. Solid-fuel rocket engines. Electrical propulsion. 4 lecture/problems. Prerequisite: ARO 311.

ARO 418 Air Pollution Control (4)

Application of engineering concepts to atmospheric pollution problems. Combustion. Reaction kinetics. Diffusion. Atmospheric emissions; particulate, gaseous. Atmospheric boundary layer. Plume rise. Photochemical smog. Control concepts. Air quality modeling. 4 lecture/problems. Prerequisites: ARO 301, ME 301.

ARO 420 Introduction to Engineering Management (4)

Elements of management. Organization of corporations, engineering groups, and government agencies. Utilization of marketing and internal research funds. Program management. Participative management. Managing technical personnel. Career enhancement. 4 lecture/ problems.

ARO 422 Advanced Aerospace Control Systems (4)

Review of classical controls. Control system design. Compensators. Nonlinear systems. Describing functions. 4 lecture/problems. Prerequisite: ARO 322.

ARO 426 Aerospace Surface Systems (4)

Aerospace fundamentals of high speed surface systems. Station-to-station concepts. Air cushion and tubeflight systems. Airload determination. Drag reduction. Propulsion systems and braking. Guideway considerations. Stability and control. 4 lecture/problems. Prerequisite: ARO 301.

ARO 427 Aeroacoustical Noise (4)

Scales and units of noise measurement. Sources and characteristics of aircraft noise. Traffic and vehicular noise. Airport noise. Noise abatement; aircraft, road vehicles, airports, highways. Sonic boom effects. 4 lectures. Prerequisite: ME 301.

ARO 431 Intermediate Finite Element Structures (4)

Structural dynamics, structural stability and advanced elements in the finite element method. Basic theory will be augmented strongly by computer programming. 4 lecture/problems. Prerequisite: ARO 408.

ARO 435L Experimental Techniques in Aerodynamics (2)

Test plan formulation. Pressure, temperature and force measurement. Test section calibration and correction. Subsonic and supersonic wind tunnel applications. 2 three-hour laboratories. Prerequisites: ARO 305, 311.

ARO 436 Mechanics of Composite Materials (4)

Mechanical behavior of composite materials. Stress/strain relations in anisotropic materials. Strength criteria and stiffness. Interlaminar stresses. Systems applications. Bending, buckling and vibration of laminated plates. 4 lecture/problems. Prerequisite: ARO 327.

ARO 461, 462 Senior Project (2) (2)

Selection and completion of an aerospace engineering project, including a literature search and use of one or more of the following approaches: theoretical, computational or experimental. Project results presented in a final, formal individual report. Project to be arranged by the student with an appropriate Aerospace Engineering faculty member who is the project supervisor. Minimum of 120 hours total time. Prerequisite: Consent of Instructor.

ARO 491 Introduction to Vehicle Design (3)

Design philosophy. Ethics. Environmental considerations. Trade-off studies. Manufacturing, facilities, cost. Aircraft, spacecraft, ground vehicles. 3 lecture/problems. Prerequisites: ARO 305, ARO 309, ARO 329, ARO 404. Corequisite: ARO 405.

ARO 492L Vehicle Design Laboratory I (2)

Conceptual preliminary design of vehicles. Design trade-offs in multidisciplined systems. Verbal and written presentations of system design. 2 three-hour laboratories. Prerequisite: ARO 491.

ARO 493L Vehicle Design Laboratory II (2)

Completion of ARO 492L design project. Preparation of final report on the project together with an oral briefing to an industrial review panel. 2 three-hour laboratories. Prerequisite: ARO 492.

ARO 499/499A/499L Special Topics for Upper Division Students (1–4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: consent of instructor. Instruction is by lecture, laboratory, or a combination of both.

AGRICULTURAL ENGINEERING

This major is being phased out. Admission to this program is closed. The following curriculum is in effect to accommodate current students. For the other program in the Agricultural Engineering/Landscape Irrigation Department, see Landscape Irrigation Science.

Eudell G. Vis, *Chair*
Joe Y.T. Hung
Ramesh Kumar

Agricultural Engineering is becoming increasingly important as agriculture grows to incorporate highly automated methods of operation. Agricultural Engineers are called upon to apply engineering principles to such interests as food engineering, soil and water, electric power and processing, power and machinery, and agricultural structures and environment.

Cal Poly offers a strong emphasis in irrigation, both in agricultural and landscape irrigation design. This Department is at the forefront in the application of drip and trickle irrigation as a method of conservation of water resources. Irrigation, drainage, flood and erosion control, and water supply require study of soils, movement of water through the soil, and design criteria for canals, ditches and small dams.

The rapid expansion in the marketing of convenience foods can lead to opportunities for the student to apply engineering principles to food process design. Students with an interest in the power and machinery area learn power testing procedures for tractors, design of hydraulic systems, the effects of noise and vibration on equipment operators, and characteristics of food products that impact machine design. The trend to large dairy, beef, swine and poultry enterprises has necessitated the automation of feed handling; a knowledge of electric power and electronic controls is necessary to engineer these complex systems.

The Agricultural Engineering curriculum is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET). Students desiring to major in Agricultural Engineering should have a particularly high aptitude for science and mathematics, and incoming freshmen should have taken substantial college preparatory courses in these disciplines in high school. Incoming transfer students should have completed at least one year of college calculus and one year of college physics (with laboratory) prior to beginning the program at Cal Poly. The community college student planning to transfer into this department should consult a school counselor or his department to determine which courses meet the program requirements.

Students are urged to consider the Integrated General Education (IGE) program as a valuable means of satisfying the General Education requirements of the degree.

Graduates of the program are prepared to do productive work in their first jobs as well as to grow with their profession throughout their engineering career. The curriculum is designed to prepare a student for direct entry into the engineering profession and for graduate school.

Agricultural Engineering students are encouraged to become active in the student branch of the American Society of Agricultural Engineers and the Agricultural Engineering Club.

CORE COURSES FOR MAJOR*

(Required of all students)

Introduction to College of Agriculture	AG	101	(1)
Engr. Digital Computations	ME	132/132L	(3)
Engineering Analysis of Agricultural Machines	AE	210	(3)
Processing Equipment and Procedures for Agricultural Products	AE	234	(3)
Agricultural Engineering Surveying	AE	245	(3)
Agricultural Engineering Computations	AE	252	(4)
Strength of Biological Materials	AE	330	(3)
Food Process Engineering	AE	332	(4)
Instruments and Controls	AE	350	(3)
Human Engineering	AE	410	(2)
Hydraulic Systems	AE	411	(3)
Farm Power and Machinery Design	AE	415	(4)
Agricultural Environments and Structures	AE	420	(3)
Irrigation Engineering	AE	440	(4)
Erosion Control & Drainage Engineering	AE	441	(4)
Senior Project	AE	461	(2)
Ag Engineering Design	AE	464	(4)
Applied Elec Engr	ECE	232	(4)
Strength of Mtrls	ME	218	(3)
Strength of Mtrls	ME	219	(3)
Strength of Mtrls Laboratory	ME	220L	(1)
Thermodynamics	ME	301	(4)
Fluid Mechanics	ME	311	(3)

SUPPORT AND ELECTIVE COURSES

(Required of all students)

Plants and Civilization	AGR	111	(4)
General Chemistry	CHM	112	(3)
General Chemistry Lab	CHM	152L	(1)
Analytic Geometry and Calculus	MAT	115	(4)
Analytic Geometry and Calculus	MAT	116	(4)
Calculus of Several Variables	MAT	214	(3)
Calculus of Several Variables	MAT	215	(3)
Differential Equations	MAT	216	(4)
Vector Statics	ME	214	(3)
Vector Dynamics	ME	215	(4)
General Physics	PHY	131	(3)
General Physics	PHY	132	
	PHY	133	(3)
General Physics Lab	PHY	152L	(1)
General Physics Lab	PHY	153L	(1)
Basic Soil Science	SS	231	(4)
Ag Sci Elec (restr'd See advisor)			(3)
Engr Design Elect (restricted)			(8)
Engr Science Elect (restricted)			(4)

GENERAL EDUCATION COURSES

Area 1:

Freshman English I	ENG	104	(4)
Advocacy and Argument	COM	204	(4)
Report Writing	COM	216	(4)

Area 2:

Analytic Geometry and Calculus	MAT	114	(4)
General Physics Lab	PHY	151L	(1)
Life Science	BIO	110	(3)
General Chemistry	CHM	111	(3)
General Chemistry Laboratory	CHM	151L	(1)
Engr. Numerical Computations	ME	330	(4)

Area 3:

Any course from Area 3A			(4)
**Ethics and Engineering Decision Making	EGR	402	(4)
Any course from Area 3C			(4)
Any course from Area 3D			(4)
Introduction to Geography	GEO	102	(4)
or Principles of Sociology	SOC	201	
Agriculture in the Modern World	AG	101	(4)
Any course from Area 3G			(4)

* A 2.0 cumulative GPA is required in core courses including option courses for the major in order to receive a degree in the major.

**Course counted in multiple categories.

Area 4:			
Introduction to American Government	PLS	201	(4)
U.S. History	HST	202	(4)
Area 5:			
Engineering Economic Decision Analysis	IE	401	(4)
Product Liability and Patents	EGR	401	(4)
**Ethics and Engr. Decision Making	EGR	402	(4)

LANDSCAPE IRRIGATION DESIGN MINOR

Principles of Irrigation	LIS	212	(4)
Landscape Hydraulics	LIS	221	(4)
Landscape Sprinkler Irrigation	LIS	231/231L	(4)
Drip Irrigation	AE	340/340L	(3)
Landscape Drainage	LIS	341	(4)
Automatic Irrigation System Controls	LIS	365/365L	(3)
Landscape Irrigation Trouble Shooting	LIS	452/452L	(3)
Total units required in minor			(30)

Course Descriptions

All courses offered by the department may be taken on a CR/NC basis except for major. For complete listing of courses in this major see the appropriate section under the College of Agriculture.

CHEMICAL AND MATERIALS ENGINEERING

Julie M. Schoenung, *Chair*
J. Winthrop Aldrich
Christopher L. Caenepeel
Edward C. Hohmann
Cordelia Ontiveros
Murray J. Roblin
Victoria T. Birrell
Barbara H. Glasscock
Thuan K. Nguyen
K. Hing Pang
Garland E. Scott, Jr.
A. George Stoll

Chemical Engineering is the branch of engineering that embraces the development and application of industrial processes which involve chemical and physical changes of material. These processes must be accomplished in a competitive economy and in an environmentally safe manner to create products which are useful and essential to the modern world. Chemical Engineering includes the design, development, and production of many products such as fuels and petrochemicals, plastics, fibers, paper, foods, building materials and pharmaceuticals. A chemical engineering degree is also good preparation for careers in pollution prevention or waste minimization.

This accredited program blends the basic sciences with engineering science and design to focus upon the design, development and engineering of industrial processes and plants. Students are well prepared upon graduation to begin either their professional career or a program of graduate study.

The chemical engineering curriculum in addition to a sound foundation in general education includes basic courses in chemistry, physics, mathematics, and materials, electrical, industrial, and mechanical engineering. In addition, coursework in the major includes computer programming, engineering statistics, material and energy balance, transport phenomena, unit operations and processes, thermodynamics, kinetics, reactor design, and pollution abatement. The design aspect of chemical engineering is present throughout the curriculum and culminates in the senior-level, three-quarter capstone design sequence. Senior project opportunities enable students to develop essential planning, experimenting and reporting skills in subjects of their choice. Extensive laboratory and computerized test facilities exist for process and materials investigations, as well as complete pilot plant scale equipment for extended development and confirmatory studies.

Courses in materials engineering are offered by the department and begin with studies in the properties and behavior of engineering materials. Emphasis is placed on the atomic, molecular, and crystalline structures, the physical properties of solids, thermodynamic properties of materials, transport phenomena, reactions, and mechanical behavior. Problems in the preparation, properties, applications of ceramics, polymers, composites, metals, and alloys are considered in light of scientific and engineering principles. Additional upper division courses in physical metallurgy, ceramics, composites, and electronic materials support the minor in materials science and engineering, as well as the chemical engineering Bachelor of Science degree. The department's materials engineering laboratories include facilities for metallography, heat treating, mechanical properties testing, particle size analysis, and advanced materials processing.

Students desiring to major in Chemical Engineering should have a particularly high aptitude for science and mathematics, and first time college students should have taken substantial college preparatory courses in these disciplines in high school including one year of chemistry. Incoming transfer students should have completed at least one year of college calculus and one year of college physics (with laboratory) prior to beginning the program at Cal Poly. The community college student planning to transfer into this department should consult a school counselor or this department to determine which courses meet the program requirements.

Chemical and Materials Engineering students are encouraged to become active in the student chapters of the American Institute of Chemical Engineers, ASM International and SAMPE. Qualified students are invited to join the student chapter of Omega Chi Epsilon, the chemical engineering honor society.

CORE COURSES FOR MAJOR *

Intro to CHE	CHE	131L	(1)
Computer Programming	CHE	132/142L	(2)
CHE Data Treatment	CHE	133/143L	(2)
Stoichiometry I	CHE	201/211L	(3)
Stoichiometry II	CHE	202/212L	(3)
Appl. Math in Chem. Engr.	CHE	301	(3)
CHE Thermo I	CHE	302	(4)
CHE Thermo II	CHE	303	(4)
Kinetics and Reactor Design	CHE	304	(4)
Momentum Transport	CHE	311	(4)
Energy Transport	CHE	312/322L	(4)
Mass Transport	CHE	313/333L	(4)
Unit Operations I	CHE	425/435L	(4)
Process Control	CHE	426/436L	(4)
Unit Operations II	CHE	427/437L	(4)
Pol. Abate. & Haz. Mat. Mgmt	CHE	432/433L	(4)
Chem Processes	CHE	441/451L	(4)
Chem Proc Syn & Des I	CHE	442/452L	(4)
Chem Proc Syn & Des II	CHE	443/453L	(4)
Senior Project	CHE	461	(2)
Senior Project	CHE	462	(2)
Undergrad Seminar	CHE	463	(2)

SUPPORT COURSES

Gen Chemistry	CHM	111	(3)
Gen Chemistry	CHM	112	(3)
Gen Chemistry	CHM	113	(3)
Physical Chemistry	CHM	313	(3)
++ Organic Chem	CHM	314/317L	(4)
++ Organic Chem	CHM	315/318L	(4)
Elem Elec Engr	ECE	231/251L	(4)
An Geom/Calculus	MAT	115	(4)
An Geom/Calculus III	MAT	116	(4)
Calc of Sev Var	MAT	214	(3)
Calc of Sev Var	MAT	215	(3)
Diff Equation	MAT	216	(4)
Vector Statics	ME	214	(3)
Strength of Materials	ME	218	(3)
Mtls Sci/Engr	MTE	207/317L	(4)
Gen Physics	PHY	132	(3)
Gen Physics	PHY	133/153L	(4)
Gen Physics	PHY	152L	(1)

GENERAL EDUCATION COURSES

An alternate pattern from that listed here for partial fulfillment of Areas 1, 3, and 4 available for students in this major is the Interdisciplinary General Education (IGE) Program. Please see the description of IGE elsewhere in this catalog.

Area 1:
Pattern 1 or Pattern 2. . . . . (12)

Area 2:

Analytic Geometry & Calculus	MAT	114	(4)
General Chemistry Laboratory	CHM	151L	(1)
General Chemistry Laboratory	CHM	152L	(1)
++ Organic Chemistry	CHM	316	(3)
Life Science	BIO	110	(3)
General Physics	PHY	131/151L	(4)

++ Community College course credit in Organic Chemistry which has been approved by the Department of Chemistry will be accepted for these courses.

* A 2.0 cumulative GPA is required in core courses including option courses for the major in order to receive a degree in the major.

Area 3:

3A Elective+			(4)
3B Elective+			(4)
3C Elective+			(4)
3D Capital Allocation Theory or 3d Elective+	EGR	403	(4)
*3E & 3F Political Sociology	SOC/PLS	390	(4)
3G Elective			(4)

Area 4:

Intro to Amer Government	PLS	201	(4)
United States History	HST	202	(4)

Area 5:

Physical Chemistry	CHM	311	(3)
Physical Chemistry	CHM	312	(3)
MTE Elective	MTE	4xx	(4)

*Course counted in multiple categories

+One course of those indicated must satisfy the American Cultural Perspectives requirement.

All underlined courses satisfy both major and GE requirements.

Course Descriptions

All students in engineering and engineering technology curricula must satisfy ENG 104 prior to enrolling in any 300-level or higher course in the College of Engineering. Lecture and laboratory courses listed together are to be taken concurrently.

CHE 131L Introduction to Chemical Engineering (1)

An introduction to chemical engineering. Business communication. Use of the personal computer to facilitate better business communication. 1 three-hour laboratory.

CHE 132/142L Computer Programming with Chemical Engineering Applications/ Laboratory (1/1)

Introductory course in BASIC structured programming covering computer systems, flowcharts, Input/Output, arrays, data files and subroutines. Students will master programming by solving chemical engineering problems in areas such as stoichiometry, fluid mechanics, heat and mass transfer. 1 lecture/ problems, 1 three-hour computational laboratory.

CHE 133/143L Chemical Engineering Data Treatment/Laboratory (1/1)

Introductory course in elementary statistics using data from Chemical Engineering experiments. Statistical and linear analysis heavily dependent on computer methods. 1 lecture/problems, 1 three-hour computational laboratory. Prerequisite: CHE 132/142.

CHE 201/211L, 202/212L Stoichiometry I/Laboratory (2/1), Stoichiometry II/Laboratory (2/1)

Material and energy balances for physical and chemical processes. Process flow diagrams. Equilibrium stage concept. Introduction to engineering design through a case study project. Practice in report writing and oral presentation of chemical process concepts. 2 lecture/problems, 1 three-hour computational laboratory. Prerequisites: CHE 132, 142, CHM 113, MAT 115. C– or better in CHE 201 and CHE 211L to advance to CHE 202/212L.

CHE 299/299A/299L Special Topics for Lower Division Students (1–4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: permission of instructor. Instruction is by lecture, laboratory, or a combination of both.

CHE 301 Applied Mathematics in Chemical Engineering (3)

A study in the application of derivative and integral concepts to solving chemical engineering problems. Use of first-order ordinary differential equations to solve transient materials and energy balances. Phase equilibrium concepts for solving binary distillation and liquid-liquid extraction problems. 3 lecture/problems. Prerequisites: CHM 113, MAT 216, C– or better in CHE 202/212L.

CHE 302 Chemical Engineering Thermodynamics I (4)

The first and second laws of thermodynamics with applications to industrial chemical processes. The phase rule, P-V-T relations of fluids, ideal and non-ideal gases. Enthalpy changes in reaction and phase transition. Heat engines, heat pumps, steam power plant, refrigeration cycles. Some problems involving process design based on thermodynamics. 4 lecture/problems. Prerequisites: PHY 132, C– or better in MAT 215 and CHE 202.

CHE 303 Chemical Engineering Thermodynamics II (4)

Phase equilibria of ideal and non-ideal systems. Concepts of fugacity, activity, and activity coefficient. Calculation of thermodynamic properties from laboratory data. Enthalpy changes of mixing. Chemical reaction equilibria. Thermodynamic design of processes involving phase equilibria. 4 lecture/problems. Prerequisites: CHE 302.

CHE 304 Kinetics and Reactor Design (4)

Chemical reaction kinetics of homogeneous and heterogeneous systems. Analysis of kinetic data. Reactor design, including batch, mixed flow, and plug flow reactors. 4 lecture/problems. Prerequisites: CHE 303.

CHE 311 Momentum Transport (4)

Basic course in fluid mechanics with emphasis on real fluids and applications to unit operations of chemical engineering, including topics in dimensional analysis, fluid properties, kinematics, and dynamics of fluid flow, friction, boundary conditions, and piping design. 4 lecture/problems. Prerequisites: ME 214, ENG 104 or ENG 102 and 103, C– or better in MAT 215, 216, and CHE 301. Corequisite: CHE 302.

CHE 312/322L Energy Transport/Laboratory (3/1)

Heat transfer with application to the unit operations of chemical engineering, including topics in energy transfer by conduction, convection and radiation, and heat exchanger design. 3 lecture/problems. 1 three-hour laboratory. Prerequisites: CHE 133/143L, 302 and 311.

CHE 313/333L Mass Transport/Laboratory (3/1)

Mass transfer and its application to the unit operations of chemical engineering, including topics in molecular diffusion, convective diffusion, simultaneous heat and mass transfer, and process design of distillation and absorption towers. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: CHE 312/322, 303.

CHE 380 Chemical Applications to Petroleum Engineering (4)

Introduction to P-V-T relations, phase equilibrium, and laws of solutions. An analysis of organic fluids used in drilling, production, and storage operations and petroleum applications of organic substances. 4 lecture/problems. Prerequisites: CHM 111, 112 and ME 101. Not open to CHE majors.

CHE 400 Special Problems for Upper Division Students (1–2)

Individual or group investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter. Prerequisite: permission of instructor.

CHE 425/435L Unit Operations I/Laboratory (3/1)

Treatment of mass, momentum and heat transport viewed with the traditional unit operations emphasis. Multicomponent and multiphase systems are considered, with some problems involving design. 3 lecture/problems, 1

three-hour laboratory. Prerequisites: All required CHE 300-level courses, CHM 312, 315, 318L.

CHE 426/436L Process Control/Laboratory (3/1)

Introduction to theory, design, and application of automatic control systems to chemical and physical processes. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: All required CHE 300-level courses.

CHE 427/437L Unit Operations II/Laboratory (3/1)

A continuation of the unit operations approach to mass, momentum and heat transfer with emphasis on collaborative design. 3 lectures. 1 three-hour laboratory. Prerequisites: All required CHE 300-level courses, CHE 425/435L.

CHE 428/438L Machine and Process Control/Laboratory (3/1)

Introduction to theory and application of automatic control to hydraulic, pneumatic, thermal, mechanical and electrical systems. Control circuit design using analog and digital controllers, microprocessor-based programmable controllers and sequencers. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ME 413, 415, and ECE 333.

CHE 432/433L Pollution Abatement and Hazardous Materials Management/Laboratory (3/1)

Identification and development of solutions to problems created in the environment by modern industry. Topics in air pollution, water pollution, and solid waste. Group project involving a comprehensive study and preliminary design, including cost analysis. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: All required CHE 300-level courses, CHM 316.

CHE 441/451L Chemical Processes/Laboratory (3/1)

Introduction to process plant design methodology. On-site study of selected process industries. Design problems related to process industries visited. 3 lecture/problems and 1 three-hour laboratory. Prerequisites: All required CHE 300-level courses, CHM 312, 315, 318L. Corequisite: CHE 425/435L.

CHE 442/452L Chemical Process Synthesis and Design I/Laboratory (3/1)

Integration of unit processes, unit operations and their economics in the synthesis of the total chemical process and plant. Use of process simulators. 3 lecture/problems and 1 three-hour computational laboratories. Prerequisites: All required CHE 300-level courses, CHE 425/435L. CHE 441/451L. Corequisite: CHE 427/437L.

CHE 443/453L Chemical Process Synthesis and Design II/Laboratory (3/1)

Economic and engineering principles guiding the selection of chemical processes, design of optimum flows and equipment, and design of process operations and a plant. Emphasis on use of process simulators. 3 lecture/problems, 1 three-hour computational laboratory. Prerequisites: All required CHE 300-level courses, CHE 425/435L, 427/437L, CHE 441/451L and CHE 442/452L.

CHE 461, 462 Senior Project (2), (2)

Formal encounter with a professional assignment, simulating the graduate chemical engineer at work and culminating in a final engineering report. Emphasis will be placed on engineering design. Prerequisites: All required CHE 300-level courses, CHM 312, 315, 318L, GPA (major and overall) >- 2.00.

CHE 463 Undergraduate Seminar (2)

Ethics and professionalism in engineering. This seminar may include research on, and presentation of, recent developments in chemical engineering, and results of senior project work. 2 seminar/discussion. Prerequisites: All required CHE 300-level courses.

CHE 499/499A/499L Special Topics for Upper Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: permission of instructor. Instruction is by lecture, laboratory, or a combination of both.

Materials Engineering

MTE 207 Materials Science and Engineering (3)

Concepts of materials science and the atomic, molecular, and crystalline structures and properties of materials with their relevance to engineering. Mechanical, electrical, thermal, and chemical properties of metals, ceramics, polymers, composites, and semiconductors are covered. 3 lecture/problems. Prerequisites: CHM 112, PHY 131 and MAT 116.

MTE 299/299A/299L Special Topics for Lower Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units with a minimum of 4 units per quarters. Prerequisite permission of instructing. Information is by lecture, laboratory is a combination of both.

MTE 317L Materials Science and Engineering Laboratory (1)

Crystallography, mechanical properties, annealing, heat treatment and environmental influences on materials. 1 three-hour laboratory. Prerequisite: MTE 207 or equivalent.

MTE 337/337L Welding Fabrication and Design (2/1)

Introduction to welding design, including properties and geometry of welded joints. Consideration of thermal effects and previous processing. Application of selected welding processes. Automation related to design. Evaluation methods. Cost factors. 2 lecture/problems, 1 three-hour laboratory. Prerequisite: ME 214, MTE 207 or equivalent.

MTE 404 Advanced Science of Materials(4)

Advanced concepts of Materials Science and their relevance to engineering. Origin of electronic, thermal, magnetic and optical properties. Structural characteristics of metals, semiconductors and dielectrics. Use of x-ray and electron microscopes in materials analysis. 4 lecture/problems. Prerequisite: MTE 207 or equivalent.

MTE 405 Physical Metallurgy-Mechanical Properties (4)

Basic principles underlying the structure and properties of crystalline solids. Metallic and covalent bonding theories; crystallography; solid solutions, intermetallic compounds and alloys. Crystal imperfections, elastic and plastic deformation. Ductile and brittle fracture, fatigue and creep. 4 lecture/problems. Prerequisite: MTE 201 or equivalent.

MTE 406/416L Physical Metallurgy-Solidification and Strengthening Reactions/ Laboratory (3/1)

Principles of solid-state reactions including elementary kinetics, nucleation and growth theory; annealing of cold-worked metals; diffusionless transformation, precipitation reactions and tempering; physical metallurgy of steels; relation between properties and microstructure. Laboratory experiments related to phase transformations in steel and precipitation hardening. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: MTE 207 or equivalent.

MTE 407/407L Ceramic Materials (3/1)

The composition, structure, and properties of ceramic bodies employed as structural and non-structural materials, with an emphasis on processing and their physical state, elasticity, strength, and optical, thermal, and electrical properties. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: MTE 207 or equivalent.

MTE 408/418L Introduction to Composite Materials/Laboratory (3/1)

Introduction to composite materials engineering processing and mechanics. Properties and processing of fibers and matrices. Polymer matrix composites, metal matrix composites, ceramic composites and carbon/carbon. Lamina and

laminate constitutive equations. Laminate strength analysis. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: MTE 207 or equivalent.

MTE 490 Lamp Design and Manufacture (4)

Basic principles and material properties used in the design and manufacture of lamps. 4 lecture/problems.

MTE 499/499A/499L Special Topics for Upper Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: permission of instructor. Instruction is by lecture, laboratory, or a combination of both.

CIVIL ENGINEERING

Ronald L. Carlyle, *Chair*
Peter R. Boniface
Peter J. Clark
Donald P. Coduto
Frank J. Janger
Howard Turner
Jerome N. Borowick
Norman C. Cluley
Hany J. Farran
Ray Morales
Donald C. Wells

The accredited program in Civil Engineering prepares graduates to enter the profession in design, construction, or management capacities on such projects as freeways, highways, major buildings, dams, bridges, aqueducts, pipelines, airports, hydro-electric installations, water treatment plants, sewage treatment plants, flood control works, and urban development programs. The department offers three options: the general civil engineering option; the environmental engineering option, and the surveying engineering option, which are separately accredited by ABET.

The general civil engineering option is selected by students desiring a broad background in the various aspects of the civil engineering profession. The environmental engineering option provides the student with a background in the acquisition and uses of water and the ability to solve environmental pollution problems caused by gaseous liquid and solid wastes. The surveying engineering option offers the civil engineering student a background in the surveying profession and in developing precise measurements for the purpose of locating and designing civil engineering projects.

Student projects and field trips are utilized to demonstrate practical applications of classroom and laboratory theory and analysis. Interactions with professional engineering technical groups and societies offer excellent opportunities for student contact with experienced, practicing engineers.

Graduates are employed by governmental agencies at federal, state, and municipal levels and by engineering contractors, private consulting firms and in the areas of sales engineering, teaching, research, materials testing, city planning, and administration fields. Graduates of the program are prepared to do productive work in their first job as well as to develop within their profession throughout their engineering career. The curriculum is designed to prepare a student for direct entry into the engineering profession, professional registration, and for graduate school.

Students desiring to major in Civil Engineering should have a particularly high aptitude for science and mathematics, and incoming freshmen should have taken substantial college preparatory courses in these disciplines in high school. Incoming transfer students should have completed at least one year of college calculus and one year of college physics (with laboratory) prior to beginning the program at Cal Poly. The community college student planning to transfer into this department should consult a school counselor or his department to determine which courses meet the program requirements.

Civil Engineering students are encouraged to become active in the student chapter of the American Society of Civil Engineers, the Structural Engineers Association of Southern California and the Institute of Transportation Engineers. Qualified students are invited to join the student chapter of Chi Epsilon, the civil engineering honor society.

CORE COURSES FOR MAJOR *

CAD Engine Concepts	CE	127/L	(3)
Elementary Surveying	CE	134/L	(4)
Computers in Civil Engineering	CE	210/L	(2)
Structural Analysis I	CE	304	(4)
Structural Analysis II	CE	305	(4)
Structural Materials Lab	CE	306L	(1)
Soil Mechanics	CE	323/L	(3)
Hydraulic Engineering	CE	332/L	(4)
Structural Design-Rein. Concrete	CE	421/422L	(5)
Foundation Engineering	CE	424	(3)
Water Supply Engineering	CE	431/L	(4)
Senior Design Project	CE	461	(2)
Senior Design Project	CE	462	(2)
Applied Electrical Engineering	ECE	232	(3)
Vector Statics	ME	214	(3)
Vector Dynamics	ME	215	(4)
Strength of Materials	ME	218	(3)
Fluid Mechanics	ME	311	(3)

OPTION COURSES FOR MAJOR *

(Required for specific option)

GENERAL CIVIL ENGINEERING

Introduction to Civil Engineering	CE	122	(1)
Advanced Surveying	CE	220/L	(4)
Highway Engineering Design	CE	222/L	(4)
Transportation Engineering	CE	223/L	(4)
Computer Programming & Numerical Methods	CE	303	(3)
Construction and Engineering Law	CE	403	(3)
Structural Design-Steel	CE	406	(3)
Steel Design Laboratory	CE	407L	(1)
Water Quality Engineering	CE	432/L	(4)
Structural Design-Timber	CE	433/L	(3)
Undergraduate Seminar	CE	463	(2)
Technical Electives in Civil Engineering	CE		(12)
Thermodynamics	ME	301	(4)

ENVIRONMENTAL ENGINEERING

Aquatic Ecology	BIO	305	(4)
Introduction to Civil Engineering	CE	122	(1)
Computer Programming & Numerical Methods	CE	303	(3)
Environmental Resource Management	CE	351/L	(4)
Construction and Engineering Law	CE	403	(3)
Structural Design-Steel	CE	406	(3)
Steel Design Laboratory	CE	407L	(1)
Water Quality Engineering	CE	432/L	(4)
Industrial and Haz Waste Mgmt.	CE	434/L	(4)
Engineering Hydrology	CE	451/L	(4)
Coastal Engineering	CE	455	(4)
Solid Waste Management	CE	457	(3)
Undergraduate Seminar	CE	463	(2)
Technical Elective in Civil Engineering	CE	XXX	(4)
Thermodynamics	ME	301	(4)

SURVEYING ENGINEERING

Advanced Surveying	CE	220/L	(4)
Highway Engineering Design	CE	222/L	(4)
Surveying Computations	CE	240	(3)
Geodetic Satellite Surveying	CE	311	(4)
Land Surveying Descriptions	CE	313	(4)
Geodetic and Electronic Surveying	CE	320/L	(4)
Boundary Control and Legal Principles	CE	322	(4)
Public Land Surveys	CE	331	(3)
Photogrammetry	CE	427/L	(4)
Engineering Hydrology	CE	451/L	(4)
Surveying Seminar	CE	464	(2)
Subdivision Design	CE	482/L	(4)
Geographical Information Systems	CE	484/L	(4)

SUPPORT COURSES

(Required of all students)

General Chemistry	CHM	111/151L	(4)
General Chemistry	CHM	112/152L	(4)
Analytic Geometry and Calculus II	MAT	115	(4)
Analytic Geometry and Calculus III	MAT	116	(4)
Calculus of Several Variables	MAT	214	(3)
Differential Equations	MAT	216	(4)

* A 2.0 cumulative GPA is required in core courses including option courses for the major in order to receive a degree in the major.

General Physics	PHY	132	(3)
General Physics	PHY	133	(3)

GENERAL EDUCATION COURSES

An alternate pattern from that listed here for partial fulfillment of Areas 1, 3, and 4 available for students in this major is the Interdisciplinary General Education (IGE) Program. Please see the description of IGE elsewhere in this catalog.

Area 1:

Freshman English I	ENG	104	(4)
Technical Communication and Documentation	CE	361	(4)
Advocacy and Argument	COM	204	(4)

Area 2:

Analytic Geometry and Calculus I	MAT	114	(4)
General Physics	PHY	131/151L	(4)
General Physics Lab	PHY	152L	(1)
General Physics Lab	PHY	153L	(1)
Life Science	BIO	110	(3)
Stat. Meth. Engg	STA	309	(3)
or Variable & Stat. Engg	IME	301	(3)

Area 3:

3A Elective			(4)
3B Elective			(4)
3C Elective			(4)
Technological Economics	CE	301	(4)
*3E & 3F Political Sociology	SOC/PLS	390	(4)
3G General Psychology	PSY	201	(4)

Area 4:

Introduction to American Government	PLS	201	(4)
United States History	HST	202	(4)

Area 5:

Geotechnology	GSC	321	(4)
+Multicultural Organizational Behavior	MHR	318	(4)

*Course counted in multiple categories

+One course of those indicated must satisfy the American Cultural Perspectives requirement. All underlined courses satisfy both major and G.E. requirements.

Course Descriptions

All students in engineering and engineering technology curricula must satisfy ENG 104 prior to enrolling in any 300-level or higher course in the College of Engineering. Lecture and laboratory courses listed together are to be taken concurrently.

CE 122 Introduction to Civil Engineering (1)

Fundamental concepts of civil engineering. The technical, professional, and social responsibilities of the civil engineer. 1 lecture/problems.

CE 127/127L CAD Engine Concepts (2/1)

Introduction to the theory of CAD engines in Civil Engineering. Primary, combined and complex elements. CAD engine deliverables. Complex shapes and libraries. Shading and multiple mapping. Group functions and customization. 2 one-hour lecture-discussions; 1-three hour laboratory.

CE 134/134L Elementary Surveying/Laboratory (2/2)

Use and care of surveying instruments, fundamental surveying methods, traverse measurements, area computations, precise equipment, 3D visualization and topographic mapping. 2 lecture/discussions, 2 three-hour laboratories. Prerequisite: MAT 106 or equivalent and CE 127/127L.

CE 210/210L Computers in Civil Engineering/Laboratory (1/1)

Application and use of the IBM (or clone) personal computer in Civil Engineering with emphasis on creating technical reports. Software instruction includes a word processor, a spreadsheet, a graphics program and elemental DOS. Actual use of software applications on an IBM or compatible personal computer with emphasis on creating technical documents. Programming in appropriate language. 1 lecture/problem. 1 three-hour laboratory.

CE 220/220L Advanced Surveying/Laboratory (3/1)

Astronomical observations. Theory of hydrographic, geodetic and control surveys. City and land surveys. Route location and layout. Simple, transition and vertical curves. Earthwork computations. Introduction to electronic and photogrammetric methods. 3 lecture/ problems, 1 three-hour laboratory. Prerequisite: CE 134.

CE 222/222L Highway Engineering Design/Laboratory (2/2)

Geometric design of highways; highway sub-structure design; roadway structural section; flexible pavement design; rigid pavement design; highway surface treatments and stabilization. 2 lecture/problems, 2 three-hour laboratories. Prerequisite: CE 220.

CE 223/223L Transportation Engineering/Laboratory (3/1)

History and operation of several principal modes of transportation. The principal modes include highways, air, inland waterways, railroads, coastwise shipping and ocean transportation. Emphasis is placed on the financing and planning aspects of transportation. Special modes are also developed. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: CE 222 or consent of instructor.

CE 240 Surveying Computations (3)

Introduction to the theory of measurements in surveying. Error propagation in horizontal and vertical position. The analysis of surveying measurement errors. Error propagation in rectangular coordinate systems. Introduction to the techniques of least squares in the adjustment of surveying data. Least squares adjustment of triangulation, trilateration and traverse networks. The use of mini-computers in surveying. 3 lecture/problems. Prerequisite: CE 220.

CE 299/299A/299L Special Topics for Lower Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limit to 8 units, with a maximum of 4 units per quarter. Prerequisite: Permission of instructor. Instruction is by lecture, laboratory, or a combination of both.

CE 301 Technological Economics (4)

Principles of long-range economic analyses; determination of investment criteria for the practicing civil engineer. Construction, managerial and urban economics; accounting, depreciation, multiple alternatives, replacement, capital budgeting. 4 lecture/problems. Prerequisite: Junior standing.

CE 303 Computer Programming and Numerical Methods (3)

Computer programming in a high level language; numerical and statistical methods as applied to civil engineering. 3 lecture/problems. Prerequisites: ME 218.

CE 304 Structural Analysis I (4)

Classification of structures, types of framing systems and loading. Statics and stability of determinate structures including cables, cantilever types, arches, beams, frames, and trusses by analytical and graphical methods. Deformation of determinate beams, frames, and trusses. Approximate methods of indeterminate frame analysis. 4 lecture/problems. Prerequisite: ME 218.

CE 305 Structural Analysis II (4)

Types and characteristics of indeterminate beams and framed structures. Analysis utilizing classical methods including consistent displacements, virtual work, slope deflection, moment distribution. Computer solutions based upon flexibility and stiffness matrices. 4 lecture/problems. Prerequisite: CE 304, and either CE 240 or CE 303..

CE 306L Structural Materials Laboratory (1)

Testing of structural elements and materials. 1 three-hour laboratory. Prerequisite: CE 305.

CE 311 Geodesy and Satellite Surveying (4)

Spherical trigonometry; cartesian and curvilinear coordinates; transformations; geodetic datums; geodetic position computation; major control network extension; satellite and terrestrial positioning system. 4 lecture/problems.

CE 313 Land Survey Descriptions (4)

History of land ownership and transfer of title; types of documents of land conveyance; forms of legal descriptions of public and private lands; interpretation of maps and documents for the physical survey location of land boundaries; principles of writing precise land boundary descriptions; study of easements; value of monuments. 4 lecture/problems.

CE 320/320L Geodetic and Electronic Surveying/Laboratory (3/1)

Total stations and data collectors; electronic data transfer and interfacing. Triangulation, trilateration and traversing. Precise leveling; astronomy, map projections and state plane coordinates. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: CE 240, 311 and 313.

CE 322 Boundary Control & Legal Principles (4)

Boundary retracement principles based on common laws. Emphasis on simultaneous conveyances, rancho lands, resurvey problems, and legal descriptions. 4 lecture/problems.

CE 323/323L Soil Mechanics/Laboratory (2/1)

Soil composition, description, and classification. Groundwater and seepage analysis. Stress analysis and stress-strain and strength properties. Consolidation and settlement analysis. Engineering properties of compacted fill. 2 lecture/problems, 1 three-hour laboratory. Prerequisite: ME 218.

CE 331 Public Land Surveys (3)

History of the general practice and rules for the survey of the Public Lands the Bureau of Land Management; System of Rectangular Surveys; Monumentation; Restoration of Lost or Obliterated Corners; Subdivision of Sections; Special surveys and instructions; Field Notes; Plats and Patents; Meander Lines and Riparian Rights (course fulfills a requirement of proposed degree program). 3 lecture/problems.

CE 332/332L Hydraulic Engineering/Laboratory (3/1)

Analysis and related design of pressure (pipe) flow. Open channel flow and special topics for civil engineers. Problems involving basic head loss equations, pipe in series and parallel, pipe networks, critical flow, uniform flow, non-uniform flow, pump stations and culverts. 3 lecture/problems. 1 three-hour laboratory. Prerequisite: ME 311.

CE 351/351L Environmental Resource Management/Laboratory (3/1)

Discussion and analysis of basic environmental skills and selected topics for the environmental engineer. Elements include population projection, curve fitting, principles of environmental systems, food production, solid waste, energy topics and noise and air pollutions. Labs emphasize field trips. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: None.

CE 361/361L Technical Communication and Documentation (3/1)

Study and preparation of documents utilized by the practicing civil engineer. Oral presentations. Proposals and bidding, specifications, environmental impact reports, journalism, technical investigations, test reports, research and development, design reports. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: ME 218, Junior standing.

CE 400 Special Problems for Upper Division Students (1-2)

Individual or group investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

CE 403 Construction and Engineering Law (3)

Principles of construction law and interpretation of contract documents. Product liability, professional liability, surveying law, patents. Relationship of owner, engineer and contractor. Preparation of technical specifications. 3 lecture/problems. Prerequisite: CE 361, Senior standing.

CE 406 Structural Design-Steel (3)

Theory and design of structural steel elements. Connection design. AISC specifications and design methods. Design of complete structural systems, including rigid frames, for both vertical and lateral loads. 3 lecture/problems. Prerequisite: CE 305. Corequisite CE 407L.

CE 407L Steel Design Laboratory (1)

Laboratory projects involving design of truss members, columns, girders, connections, and integration of these elements into a complete structure. 1 three hour laboratory. Corequisite: CE 406.

CE 421 Structural Design-Reinforced Concrete (4)

Analysis, design and detailing of reinforced concrete structural components including beams, slabs and columns; with emphasis on strength design theory. Elements of integrated building design with primary emphasis on the impact of lateral forces on building stability. Introduction to working stress theory. 4 lecture/problems. Prerequisite: CE 305. Corequisite: CE 422L

CE 422L Concrete Design Laboratory (1)

Composition, proportioning and testing of concrete mixes. Testing of model reinforced concrete beams. 1 three hour laboratory. Corequisite: CE 421.

CE 424 Foundation Engineering (3)

Geotechnical and structure analysis and design of foundations, including spread footings, mats, drilled shafts, and piles. Lateral earth pressures and design of cantilever retaining walls. 3 lecture/problems. Prerequisites: CE 323, CE 421.

CE 427/427L Photogrammetry (3/1)

Interpretation of aerial photographs. Stereoscopy. Application of aerial surveying to engineering problems, mapping. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: CE 134.

CE 428 Urban Transportation (3)

History, nature of problem, impact on the urban area, alternative solutions, costs of modernization, mass transit trends, the subsidy debate, role of the State and Federal governments, the nature and importance of planning. 3 lecture/problems. Prerequisite: CE 223 or consent of instructor.

CE 429/429L Traffic Engineering/Laboratory (3/1)

Driver and vehicle characteristics. Origin and destination studies. Volume, speed and accident studies. Traffic control devices. Channelization design. Parking facilities design. Intersection design. Roadway lighting. Administration and financing of improvements. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: CE 222.

CE 431/431L Water Supply Engineering/Laboratory (3/1)

Water pollutants and unit process treatment. Subjects include water quality, water uses, aeration, sedimentation, coagulation, flocculation, filtration, softening, disinfection, iron and manganese removal, and saline water conversion. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: CE 332.

CE 432/432L Water Quality Engineering/Laboratory (3/1)

Wastewater characteristics and unit process. Subjects include characteristics of wastewater, sewer design, requirements for disposal, preliminary treatment, biological processes, anaerobic digestion, sludge processing and oxygen sag. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: CE 431.

CE 433/433L Structural Design-Timber/Laboratory (2/1)

Design load requirements. Seismic analysis. Fire resistive requirements. Design of wood structural elements including sawn lumber, glue-laminated timber, and plywood. Connection design. Design of complete structural systems for both vertical and lateral loads. 2 lecture/problems, 1 three-hour laboratory. Prerequisite: CE 304.

CE 434/434L Industrial and Hazardous Waste Management/Laboratory (3/1)

Source and treatment of industrial waste waters. Elements include materials of construction, volume reduction, neutralization, control and instrumentation, removal of suspended solids, common industrial processes. Major project and associated field trip required. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: CE 432.

CE 437/437L Slope Stability and Earth Dams/Laboratory (3/1)

Advanced analysis of seepage through soil and soil strength. Evaluation of the stability of earth slopes and design of stable slopes including the use of computer analysis methods. Design and construction of earth dams. Use of soil instrumentation. Field trips. 3 lecture/problems, one 3-hour laboratory. Prerequisite: CE 323.

CE 442 Masonry Design (4)

Properties of clay brick and concrete masonry materials. Analysis and design of reinforced masonry members, and structural systems with emphasis on lateral force analysis of masonry structures and their connections. Reinforced masonry applications in high rise construction. 4 lecture/problems. Prerequisite: CE 421.

CE 445 Earthquake Engineering (4)

Modes of vibration, structural response, observed behavior, and preventive design measures. Implementation of Uniform Building Code and Structural Engineers Association of California requirements. 4 lecture/problems. Prerequisites: CE 406 or CE 421.

CE 451/451L Engineering Hydrology (3/1)

Precipitation; weather modification; evaporation; infiltration; hydrographs; probability concepts; river and reservoir routing; groundwater; wells; flow nets; dam spillways; and storm drains. 3 lecture/problems, 1 three-hour problem session. Prerequisite: CE 332.

CE 453/453L Construction Engineering and Management (3/1)

Principles of construction engineering, techniques and management. Analysis and selection of equipment design of temporary support structures. Joint design. Construction planning and management, CPM, cost estimation, computer techniques, construction law. Use of construction tools and equipment. 3 lecture/problems, 1 three-hour laboratory.

CE 455 Coastal Engineering (4)

Linear and non-linear wave theories; effects of structures on waves; wave forces; breakwaters; harbor structures; impulsively generated waves; wind waves, measuring waves, waves in shoaling water; breakers and the surf; shores and beaches; tides; harbor oscillations and resonance; mixing processes; pollution and mining. 4 lecture/problems. Prerequisite: CE 332 or consent of instructor.

CE 457 Solid Waste Management (3)

Elements include waste generation, storage, collection, transfer, transport, processing, recovery, and disposal. 3 lecture/problems. Prerequisites: Junior standing in Civil Engineering or consent of instructor.

CE 461, 462 Senior Design Project (2) (2)

Synthesis of previous coursework into a Civil Engineering design project. Students complete the project under the supervision of a faculty member. Minimum 120 hours total time. Prerequisite: Senior standing and CE 463 or 464.

CE 463/463L Undergraduate Seminar (1/1)

Class discussions and student assignments relating career management, professional development and ethics to the civil engineering professional. Engineering judgment; decision-making; social issues. Formulation of senior project. 1 lecture, 1 three-hour laboratory. Prerequisite: CE 361, senior standing.

CE 464 Surveying Seminar (2)

Surveying ethics and liability. Laws pertaining to professional practice, surveying business and research practice, functions of county offices. Planning and design of boundary, architects, ALTA, topographic, condominium and subdivision surveys and plans. 2 discussions. Prerequisites: CE 322, 313 and 331.

CE 476 Bridge Design (4)

Structural analysis and design of modern bridge structures. Comprehensive study of influence lines and their application to moving loads. Application of AASHTO specifications to bridge design. Design of steel, reinforced concrete and prestressed concrete bridge structures. Introduction to long span cable-stayed and suspension bridges. Aerodynamic performance of bridges under wind loads. Earthquake response of bridges. Bridge infrastructure, maintenance and rehabilitation. 4 lecture/problems. Prerequisites: CE 406 and 407L, or CE 421 and 422L.

CE 482/482L Subdivision Design (3/1)

Engineering and surveying methods in land use planning, design, and construction. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: CE 222, CE 332.

CE 484/484L Design of Geographical Information Systems /Laboratory (3/1)

Introduction to the theory of spatial information systems. Maps as information systems. Spatial information system theory and feedback. Design of data capture models. Design of data display and output models. Design of data storage and data manipulation models. Design of data dissemination models. The design of spatial information systems in engineering practice. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: CE 134/144L.

CE 491/491A, 492/492A, 493/493A Comprehensive Civil Engineering Design I, II, III (1/2,1/1,1/2)

Completion of a comprehensive design project that encompasses multiple disciplines within civil engineering. Projects are performed in student groups working under the supervision of multiple faculty members. Prerequisites for CE 491: CE 406 or CE 431.

CE 499/499A/499L Special Topics for Upper Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units with a maximum of 4 units per quarter. Prerequisite: permission of instructor. Instruction is by lecture, laboratory, or a combination of both.

ELECTRICAL AND COMPUTER ENGINEERING

Richard H. Cockrum, *Chair*
Robert L. Bernick
David L. Clark
M. Samy El-Sawah
Lloyd N. Ferguson, Jr.
Laurence D. Graham
M. Kathleen Hayden
Elhami T. Ibrahim
Henslay W. Kabisama
Alexander E. Koutras
Mohammad A. Massoudi
Norman S. Nise
Mohamed Rafiquzzaman
Wendy K. Wanderman
Yi Cheng
Mahmoud Davarpanah
Alan P. Felzer
Dennis J. Fitzgerald
Milton E. Hamilton
Hua K. Hwang
Robert G. Irvine
James S. Kang
Anaiuppam R. Marudarajan
Narayan R. Mysoor
John P. Palmer
Toma H. Sacco
Arthur W. Sutton Jr.

The Department of Electrical and Computer Engineering offers options in Computer Engineering, Electronic Engineering, and Electrical Engineering. These options, similar at the freshman and sophomore levels, diverge at the junior and senior levels into various areas of specialization. In addition to the options within the curriculum, the department offers six SPE's (Specified Program of Electives) in Power Engineering, Electronic Instrumentation and Measurement Science, Laser Electronics, Microwave Engineering, Process Control Electronics, and Robotics. Students may specify their Major Option Courses in one of these areas.

The department's principal objective is to provide a sound theoretical background along with current practical engineering knowledge to each student. The accredited curriculum includes a large number of laboratories where practical application of classroom theory is experienced by the student. Additionally, a senior design/fabrication/evaluation project is required of all undergraduate students. Students are well prepared upon graduation to begin either their professional career or a program of graduate study.

Graduates from the ECE department are in demand by a broad cross-section of industry, government, public utilities, marketing groups and educational institutions because of the effective integration of theory and practical experience within the curriculum. The students are prepared for employment in design and development, test and evaluation, and applied research.

Students desiring to major in Electrical and Computer Engineering should have a particularly high aptitude for science and mathematics, and incoming freshmen should have taken substantial college preparatory courses in these disciplines in high school. The community college student planning to transfer into this department should consult a school counselor or this department to determine which courses meet the program requirements.

Electrical and Computer Engineering students are encouraged to become active in the student chapter of the Institute of Electrical and Electronic Engineers, or the Cal Poly Amateur Radio Club. Qualified students are invited to join the student chapter of Eta Kappa Nu, the national electrical engineering honor society.

PHYSIOLOGY MINOR

ECE majors specializing in Biomedical Engineering are encouraged to take the Physiology Minor. See the University Programs section of this catalog for details.

CORE COURSES FOR MAJOR*

(Required of all students)

Introduction to Electrical Engineering	ECE	109/129L	(4)
C for Engineers	ECE	114	(3)
Introduction to Digital Systems I	ECE	204	(4)
Network Analysis I	ECE	207	(3)
Network Analysis II	ECE	209	(3)
Electronic Devices and Circuits	ECE	220	(3)
Introduction to Digital Systems I Lab	ECE	244L	(1)
Network Analysis I Lab	ECE	252L	(1)
Network Analysis II Lab	ECE	253L	(1)
Electronics Lab	ECE	270L	(1)
Network Analysis III	ECE	307	(4)
Control Systems Engineering	ECE	309	(4)
Introduction to Power Engineering	ECE	310	(4)
Introduction to Communications Engineering	ECE	315	(4)
Linear Active Circuit Design	ECE	320	(3)
Intro to Semiconductor Devices	ECE	330	(3)
Computer Engineering I	ECE	341	(4)
Computer Simulation of Dynamic Systems	ECE	357L	(1)
Control Systems Laboratory	ECE	359L	(1)
Power Engineering Laboratory	ECE	360L	(1)
Basic Active Circuits Lab	ECE	370L	(1)
Computer Engineering I Lab	ECE	391L	(1)
Communications Systems	ECE	405	(4)
Communications Lab	ECE	445L	(1)
Senior Project	ECE	461	(2)
Senior Project	ECE	462	(2)
Undergraduate Seminar	ECE	463	(2)

OPTION COURSES FOR MAJOR*

(Required for the Specific Option)

COMPUTER ENGINEERING

Comp Engr II	ECE	342/392L	(5)
U. D. Elective from app. department list	ECE/CS	xxx	(4)
ECE/CS ELECT I, II, III, IV			(16)
Data Structures	ECE	303	(4)
Dig Elect	ECE	325/375L	(4)
Comp Engr III	ECE	343/393L	(4)
Robotics: Electronics I	ECE	404/454L	(4)
Intro Dig Sign Proc	ECE	408	(4)
Dig Comm Sys	ECE	409	(4)
Micro Apps Proc Cont	ECE	414/444L	(4)
State Mach Des	ECE	424/474L	(4)
Sel Topics Comp Engr	ECE	425/475L	(4)
Comp Org & Prog	ECE	426/476L	(4)
Adv Dig Topics	ECE	427/477L	(4)
Micro Apps	ECE	432/482L	(4)
Oper Systems	CS	431	(4)

ELECTRONICS ENGINEERING

Operational Amplifiers and Signal Conditioning	ECE	322	(4)
Instrumentation Systems	ECE	323/373L	(4)
Operational Amplifiers and Signal Conditioning Lab	ECE	372L	(1)
Electromagnetic Field and Applications	ECE	406	(3)
R. F. Transmission Line Lab	ECE	446L	(1)

Any 3 of the following courses:

Intro to Filter Design	ECE	403	(4)
Advanced Circuit Design	ECE	407/457L	(4)
Digital Communication Systems	ECE	409	(4)
Microwave Eng'g (Lect./Lab)	ECE	410/460L	(4)
Solid State Electronics	ECE	412	(4)
Integrated Circuit design	ECE	418	(4)
Lasers	ECE	420	(4)
Ocean Electronics	ECE	434	(4)
Optical Fiber Communications	ECE	436	(4)
R.F. Design	ECE	448/498L	(4)

* A 2.0 cumulative GPA is required in core courses including option courses for the major in order to receive a degree in the major.

ELECTRICAL ENGINEERING

Suggested Specified Programs of Electives for Electrical Engineering Option

25 units of upper division ECE Engineering Science or Design electives.

POWER ENGINEERING

Electromechanics I	ECE	317/367L	(5)
Electromechanics II	ECE	318/368L	(5)
Energy Conversion Systems I	ECE	421/451L	(4)
Energy Conversion Systems II	ECE	422/452L	(4)
Power Electronics I	ECE	468/478L	(4)
Power Electronics II	ECE	469/479L	(4)

ELECTRONIC INSTRUMENTATION AND MEASUREMENT SCIENCE

LASER ELECTRONICS

MICROWAVE ENGINEERING

PROCESS CONTROL ELECTRONICS

ROBOTICS

SUPPORT AND DIRECTED ELECTIVES

Analytic Geom & Calc	MAT	115	(4)
Analytic Geom & Calc	MAT	116	(4)
Calc Sev Var	MAT	214	(3)
Calc Sev Var	MAT	215	(3)
Diff Equations	MAT	216	(4)
Vector Statics	ME	214	(3)
Vector Dynamics	ME	215	(4)
Matls Sci/Eng	MTE	207	(3)
General Physics	PHY	132	(3)
General Physics	PHY	133/153L	(4)
General Chemistry	CHM	111/151L	(4)
General Chemistry	CHM	112/152L	(4)

GENERAL EDUCATION COURSES

An alternate pattern from that listed here for partial fulfillment of Areas 1, 3, and 4 available for students in this major is the Interdisciplinary General Education (IGE) Program. Please see the description of IGE elsewhere in this catalog.

Area 1:

Freshman English I	ENG	104	(4)
Advocacy and Argument	COM	204	(4)
Egr Reports, Specs, and Proposals	ECE	311	(4)

Area 2:

Analytic Geom & Calc	MAT	114	(4)
Life Science	BIO	110	(3)
General Physics	PHY	131/151L/152L	(5)
Electromagnetic Fields	ECE	302	(4)

Area 3:

3A Elective+			(4)
3B Elective+			(4)
3C Elective+			(4)
3D Principles of Economics	EC	201	(4)
OR			
Principles of Economics	EC	202	
*3F & 3F Political Sociology	SOC/PLS	390	(4)
3G Elective+			(4)

Area 4:

Political Science	PLS	201	(4)
U.S. History	HST	202	(4)

Area 5:

EGR 402(4) and EGR 403(4)

*Course counted in multiple categories.

+One course of those indicated must satisfy the American Cultural.

Perspectives requirement. Underlined courses satisfy both major and G.E. requirements.

Course Descriptions

All students in engineering and engineering technology curricula must satisfy ENG 104 prior to enrolling in any 300-level or higher course in the College of Engineering. Lecture and laboratory courses listed together are to be taken concurrently.

CAUTION: Course descriptions show only immediate prerequisite courses, but those courses may in turn have prerequisite courses. It is the student's responsibility to be aware of all prerequisites for a course, direct and indirect.

ECE 109 Introduction to Electrical Engineering (3)

Introduction to the fundamental laws of electrical engineering, applications to circuit analysis, matrix methods. 3 lecture/problems. Prerequisite: MAT 114, concurrent ECE 129L.

ECE 114 C for Engineers (3)

Computer programming for ECE. Problem-oriented computer language applications to electrical networks. Prerequisite: MAT 114.

ECE 129L Introduction to Electrical Engineering Lab (1)

Selected laboratory experiments emphasizing the use and operation of electrical test equipment. 1 three-hour laboratory. Concurrent ECE 109.

ECE 200 Special Problems for Lower Division Students (1-2)

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

ECE 204 Introduction to Digital Systems I (4)

Characteristics and applications of the basic building blocks of digital systems. 4 lecture/problems. Prerequisite: ECE 114, 109, 129L.

ECE 207 Network Analysis I (3)

An introduction to network analysis in the time domain with computer applications. 3 lecture/problems. Prerequisites: ECE 109, ECE 114, ECE 129L, MAT 216, PHY 133.

ECE 209 Network Analysis II (3)

An introduction to network analysis in the frequency domain with computer applications. Continuation of ECE 208. 3 lecture/problems. Prerequisite: ECE 207, 252L.

ECE 220 Electronic Devices and Circuits (3)

Fundamentals of semiconductor devices. Characteristics of diodes, bipolar transistors, JFET's and MOSFET's. Basic biasing circuits. 3 lecture/problems. Prerequisites: ECE 114, ECE 207, MAT 216, PHY 133, CHM 111.

ECE 231/251L Elements of Electrical Engineering/Laboratory (3/1)

Electrical principles, DC and AC circuit analysis, simple transients, three phase circuits, magnetics and transformers for non-electrical engineering majors. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: MAT 116; PHY 133.

ECE 232 Applied Electrical Engineering (3)

Electrical principles, DC and AC circuits analysis, three phase circuits, industrial wiring practice, electrical instruments and measurements. For Civil and Agricultural Engineering majors. 4 lecture/problems. Prerequisites: MAT 116; PHY 133.

ECE 244L Introduction to Digital Systems I Lab (1)

Experiments demonstrating characteristics and applications of the basic building blocks of digital systems. One 3-hour laboratory. Prerequisite: ECE 129L, 204.

ECE 252L Network Analysis I Lab (1)

Selected laboratory exercises in electrical networks. One 3-hour laboratory. Prerequisite: ECE 129L, 207, PHY 153L.

ECE 253L Network Analysis II Lab (1)

Selected laboratory exercises in electrical networks. One 3-hour laboratory. Prerequisite: ECE 209, 252L.

ECE 270L Electronics Laboratory (1)

Fundamental experiments concerned with the common types of semiconductor devices. 1 three-hour laboratory. Prerequisite: ECE 129L. Prerequisite or concurrent: ECE 220.

ECE 299/299A/299L Special Topics for Lower Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Permission of instructor. Instruction is by lecture, laboratory or a combination of both.

ECE 302 Electromagnetic Fields (4)

Static electric and magnetic fields; LaPlace, Poisson and Maxwell's equations; introduction to time varying fields. 4 lecture/problems. Prerequisites: MAT 215, 216, PHY 133.

ECE 303 Data Structures for Electrical Engineers (4)

The programming language C and its applications to electrical engineering problems. 4 lecture/problems. Prerequisites: ECE 114 and 209 and MAT 216.

ECE 307 Network Analysis III (4)

Analysis of network functions in the time and frequency domains. 4 lecture/problems. Prerequisite: ECE 209.

ECE 309 Control Systems Engineering (4)

System representation and performance specifications. Design and analysis of feedback control system via root locus and frequency response. Compensation design techniques. 4 lecture/problems. Prerequisite: ECE 307.

ECE 310 Introduction to Power Engineering (4)

Basic principles of power engineering with emphasis on rotating AC and DC machines. Magnetic fields, magnetic material characteristics, and magnetic circuits. AC and DC machine principles, operation models of AC motors and transformers. Polyphase systems and the power system; network representation using phasors. Introduction to codes and standards as they apply to power engineering. 4 lecture/discussions. Prerequisite: ECE 209.

ECE 311 Engineering Reports, Specifications and Proposals (4)

Techniques of conveying and interpreting technical information, developing a facility with engineering language, both written and oral, reading drawings, making sketches and reading schematics, technical proposals. Avoiding technical, legal and manufacturing pitfalls in engineering specification. 4 lecture/problems. Prerequisites: ENG 104, ECE 320, 204.

ECE 315 Introduction to Communications Engineering (4)

Analysis of random phenomena associated with the transmission of digital and analog signals. Analysis of random binary signals, optimum filtering, thermal noise, and signal to noise ratios. 4 lecture/problems. Prerequisites: ECE 307; MAT 215.

ECE 317/367L Electromechanics I/Laboratory (4/1)

In depth treatment of magnetics, transformers and rotating machinery with emphasis on the analysis, operation and applications of DC machines. Dynamic response and control schemes including various types of DC controllers. Introduction to AC machines. 4 lecture/ problems. 1 three-hour laboratory. Prerequisites: ECE 310, 302, 360L.

ECE 318/368L Electromechanics II/Laboratory (4/1)

Continuation of ECE 317 with emphasis on AC machine analysis, operation, and applications. 4 lecture/problems, 1 three-hour laboratory. Prerequisite: ECE 317, 309.

ECE 320 Linear Active Circuit Design (3)

Analysis and design of single and multiple stage transistor amplifiers. Differential, cascade and Darlington amplifiers. Large signal amplifiers. 3 lecture/problems. Prerequisite: ECE 220. Corequisite: ECE 307.

ECE 322 Operational Amplifiers and Signal Conditioning (4)

Elements of electronic circuit feedback. Operational amplifier systems. Waveshaping circuits and sources. 4 lecture/problems. Prerequisite: ECE 320.

ECE 323/373L Instrumentation Systems/Laboratory (3/1)

Components of Instrumentation Systems. Typical power supplies and signal conditioners. A/D and D/A converters. Sensors for various parameters. Error analysis, readouts, recorders and actuators. 3 lecture/problems and 1 three-hour laboratory. Prerequisites: ECE 315, 322, 372L.

ECE 325/375L Electronic Design of Digital Circuits/Laboratory (3/1)

Device structures for primary logic families. Analysis of switching characteristics and waveform propagation. Structures of various memory devices, logic arrays, and display devices. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ECE 204, 220.

ECE 330 Introduction to Semiconductor Devices (3)

Fundamentals of semiconductor devices. Characteristics of junction diodes and bipolar, junction field effect, and metal oxide field effect transistors. 3 lecture/problems. Prerequisites: ECE 220 and MTE 207.

ECE 333/383L Electronic Instrumentation and Control/Laboratory (3/1)

Principles and applications of instruments, transducers, readouts, instrumentation systems, amplifiers and signal conditioners, loading, impedance matching, frequency and time response, elementary feedback systems. For non-electrical engineering majors. 3 lecture/problems. 1 three-hour laboratory. Prerequisites: ECE 231/251L, MAT 216.

ECE 341/391L Computer Engineering I/Laboratory (4/1)

Analysis and design of Computer Engineering Systems. 4 lecture/problems, 1 three-hour laboratory. Prerequisites: ECE 204, 244L.

ECE 342 Computer Engineering II (4)

Analysis and design of Computer Engineering Systems, including computer architecture. 4 lecture/problems. Prerequisite: ECE 341, 391L.

ECE 343/393L Computer Engineering III/Laboratory (4/1)

Analysis and design of Computer Engineering Systems, including microprocessors. 4 lecture/problems, 1 three-hour laboratory. Prerequisites: ECE 342, 392L.

ECE 353/355L Computer Electronics I/Laboratory (3/1)

Basic principles and applications of diodes, transistors, MOS transistors. 3 lecture/problems and 1 three-hour laboratory. Prerequisites: PHY 133. CS 210 is required for CS majors only. Not open to ECE majors.

ECE 354/356L Computer Electronics II/Laboratory (3/1)

TTL and MOS Logic Device Application. Arithmetic Logic Unit, register array and multiplexer/demultiplexer applications. Use of tristate gating. Bus systems. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: ECE 353/355L. Not open to ECE majors.

ECE 357L Computer Simulation of Dynamic Systems (1)

Analog and digital simulation of dynamic systems utilizing time and frequency modeling techniques. 1 three-hour laboratory. Prerequisite: ECE 307.

ECE 359L Control Systems Laboratory (1)

Control system design assignments based upon the course work of ECE 309. Verification of design solutions through analog and digital simulations. 1 three-hour laboratory. Prerequisites: ECE 309, 357L.

ECE 360L Power Engineering Laboratory (1)

Selected experiments in power engineering including magnetics, transformers, machinery and power network analysis. 1 three-hour laboratory. Prerequisite or concurrent: ECE 310.

ECE 370L Basic Active Circuit Lab (1)

Design and evaluation of basic amplifier circuits, single and multistage. 1 three-hour laboratory. Prerequisite: ECE 270L. Prerequisite or concurrent: ECE 320.

ECE 372L Operational Amplifiers and Signal Conditioning Lab (1)

Design and evaluation of feedback OP-AMP, oscillator, and signal conditioning circuits. 1 three-hour laboratory. Prerequisite: ECE 370L. Prerequisite or concurrent: ECE 322.

ECE 392L Computer Engineering II Laboratory (1)

Experiments demonstrating analysis and design of Computer-Engineering Systems, including computer architecture. 1 three-hour laboratory. Prerequisites: ECE 342, 391L.

ECE 400 Special Problems for Upper Division Students (1-2)

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

ECE 403 Introduction to Filter Design (4)

An introduction to the design of passive and active filters. Sensitivity analysis. 4 lecture/problems. Prerequisite: ECE 307, 322.

ECE 404/454L Robotic Electronics I/Laboratory (3/1)

Basic principles of robotics; kinematics and dynamics; sensing; low-level vision; robotics actuators; programming; simple applications. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: ECE 309.

ECE 405 Communications Systems (4)

The study of various types of communication systems with emphasis on their analysis in the frequency domain. The role of system bandwidth and noise rejection in limiting the transmission and reception of information included. 4 lecture/problems. Prerequisites: ECE 307, 315.

ECE 406 Electromagnetic Fields and Applications (3)

Electromagnetic fields and Maxwell's equations. Wave equations, reflection and scattering of waves. Transmission line equations and solutions. Impedance matching. 3 lecture/problems. Prerequisite: ECE 302. Concurrent: ECE 446L.

ECE 407/457L Advanced Circuit Design/Laboratory (3/1)

Design and evaluation of advanced linear circuits utilizing state-of-the-art electronic devices. 3 lecture/problems and 1 three-hour laboratory. Prerequisites: ECE 322, 307, 372L.

ECE 408 Introduction to Digital Signal Processing I (4)

An introduction to digital signal processing and digital filters. 4 lecture/ problems. Prerequisite: ECE 307.

ECE 409 Digital Communication Systems (4)

Introduction to digital and data communication systems, sampling, modulation techniques, time division multiplexing, performance of digital communication systems. 4 lecture/problems. Prerequisite: ECE 405.

ECE 410 Microwave Engineering (3)

Principles of waveguide devices, active microwave devices, and circuits. Scattering parameter techniques, FET amplifiers. Microwave generation. 3 lecture/problems. Prerequisites: ECE 406, 446L.

ECE 412 Solid State Electronics (4)

Physics and technology of solid state electronic devices with emphasis on recent developments in the field. 4 lecture/problems. Prerequisite: ECE 322.

ECE 414/444L Microprocessor Applications in Process Control/Laboratory (3/1)

Process control fundamentals. Analog and digital signal conditioning, z-transformation techniques. Digital controller principles. Design of discrete time control systems. Development of digital control algorithms for microprocessor-based control systems. Distributed microprocessor control systems. 3 lecture/problems. 1 three-hour laboratory. Prerequisites: ECE 309, 359L and 341, 391L.

ECE 418 Integrated Circuit Design (4)

Integrated circuit processing design rules for integrated circuit layout. VLSI CMOS circuits. Introduction to layout tools and exercises. 4 lecture/problems. Prerequisite: ECE 412.

ECE 419/489L Advanced Control Systems/Laboratory (3/1)

Time-domain and frequency-domain design of control systems; concepts of state and state space; description of dynamic systems in state-variable format; canonical form; controllability and observability; state feedback and state estimation; applications and hardware. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: ECE 309.

ECE 420 Lasers (4)

Fundamental principles and applications of lasers, energy levels and mechanisms of excitation, basic types of lasers. Q switching and modes. Modulation and detection. 4 lecture/problems. Prerequisites: ECE 302.

ECE 421/451L Energy Conversion Systems I/Laboratory (3/1)

Advanced and special methods of analysis of power systems, symmetrical components, representation of power systems, use of power systems analysis software for the solution of systems problems, power system transmission line concepts. 3 lecture/problems. 1 three-hour laboratory. Prerequisites: ECE 318, or 310 and permission of instructor.

ECE 422/452L Energy Conversion Systems II/Laboratory (3/1)

System stability and fault conditions, specific design considerations, load flow studies, economic operation practices. Standards and requirements governing industrial and utility system operations. 3 lecture/problems. Use of computer software for load flow and stability analysis. 1 three-hour laboratory. Prerequisite: ECE 421/451L.

ECE 424/474L State Machine Design/Laboratory (3/1)

Analysis and design of synchronous and asynchronous state machines. 3 lecture/problems, 1 three-hour lab. Prerequisites: ECE 341, 391L.

ECE 425/475L Selected Topics in Computer Engineering/Laboratory (3/1)

Selected Topics in Computer Engineering such as RISC architecture and organization and operating systems for open computing. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: ECE 424/474L.

ECE 426/476L Computer Organization and Programming/Laboratory (3/1)

Advanced concepts of computer and firmware engineering topics, such as architecture, instruction sets, system internals and effective programming techniques shall be discussed in depth. The laboratory component will consist of assembly language programming on both the PDP-11 and VAX-11. 3 lecture/problems; 1 three-hour laboratory. Prerequisite: ECE 392L.

ECE 427/477L Advanced Digital Topics/Laboratory (3/1)

Theory and standards for interfacing LSI and VLSI digital subsystems. Organization of selected VLSI subsystems. 3 one-hour lecture/problems; 1 three-hour laboratory. Prerequisite: ECE 392L.

ECE 428 Digital Signal Processing II (4)

A continuation of digital filter design and an introduction to digital signal processing algorithms. 4 lecture/problems. Prerequisite: ECE 408.

ECE 432/482L Microcomputer Applications/Laboratory (3/1)

Microcomputer applications at the systems level. Course to include usage of both hardware and software design aids. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: ECE 343, 393L.

ECE 434 Ocean Electronics (4)

Electronic Instrumentation for basic underwater measurements of ocean depths, currents, wave motion, salinity, water analysis, etc. Data buoy instrumentation systems. Basic ocean surface electronics for communication, navigation, weather, underwater acoustics transducers. 4 lectures and one or more ocean field trips. Prerequisite: ECE 323 or 333.

ECE 435 Biomedical Instrumentation and Measurements (3)

Discussion of major body systems in terms of their physiology, measurable parameters and current instrumentation. The application of sound engineering principles to obtain reliable physiological data. A system design. 3 lecture/problems. Prerequisites: BIO 110; ECE 323 or 333, or consent of instructor.

ECE 436 Optical Fiber Communications (4)

Introduction to optical fibers and optical fiber cables. Coupling and cabling. Optical sources and detectors and their application to optical communications. Modulation methods. Noise in detectors. Design and evaluation of optical transmitters, receivers, repeaters and multinetworks. Design specifications, options, tradeoffs and cost. Integrated optics and laser technology applied to optical communications. New developments. 4 lecture/problems. Prerequisites: ECE 302, 330.

ECE 445L Communications Lab (1)

Demonstrations of the individual aspects of communication technique. 1 three-hour laboratory. Prerequisite: ECE 405, 357L.

ECE 446L R. F. Transmission Line Laboratory (1)

Experimental consideration of the characteristics and behavior of R.F. transmission lines. Stub matching and transmission line parameter measurements by several methods. 1 three-hour laboratory. Prerequisite: ECE 302. Concurrent: ECE 406.

ECE 448/498L R.F. Design/Laboratory (3/1)

Principles of R.F. design of transmitters and receivers utilizing solid state electronics devices and integrated circuits. Design of oscillators, power amplifiers, mixers and detectors. 3 lecture/problems and 1 three-hour laboratory. Prerequisites: ECE 320, 406 or consent of instructor.

ECE 460L Microwave Measurements (1)

Electronic measurement equipment and techniques for measurements at microwave frequencies of such quantities as power, impedance, standing wave ratio and frequency, and impedance matching. Frequency domain reflectometry. Gunn oscillator characteristics. 1 three-hour laboratory. Prerequisites: ECE 406 and 446. Corequisite: ECE 410.

ECE 461, 462 Senior Project (2) (2)

Completion of a project under faculty supervision. Project results are presented in a formal report. Minimum 120 hours total time. Prerequisite: ECE 463.

ECE 463 Undergraduate Seminar (2)

New developments, policies, practices, procedures and ethics in electrical and computer engineering. Each student is responsible for the preparation of an approved project proposal in the field of electrical and computer engineering. 2 one-hour lecture/problem-solving sessions. Prerequisites: Completion of all 100-200 level courses, COM 216 or ECE 311, and all but 12 units of required 300 level courses. Satisfactory completion of Graduate Writing Test. Must be within 50 units of completing overall unit requirements for graduation.

ECE 468/478L Power Electronics I/Laboratory (3/1)

Basic Principles of Power Semiconductor Switching with emphasis on analysis and design criteria of D.C. voltage controllers, controlled rectifiers and converters. Selected applications to electrical machines and controls. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ECE 270L, 310, 360L.

ECE 469/479L Power Electronics II/Laboratory (3/1)

Continuation of ECE 468 with emphasis on the analysis and design criteria of D.C. to D.C. converters (choppers), D.C. to A.C. inverters, and A.C. to A.C. converters. Selected control schemes and applications. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ECE 317/367L, ECE 468/478L.

ECE 485L Biomedical Instrumentation and Measurements Lab (1)

Selected Experiments pertaining to biomedical instrumentation. 1 three-hour laboratory. Prerequisite: ECE 435.

ECE 490/490L Illumination Engineering (4/1)

An introduction to lighting design, lamps, controls, and luminaries with an emphasis on lighting measurements and calculations. 4 lecture/problems, 1 three-hour laboratory.

ECE 492 Lighting Control/Design (4)

Lighting controls, state and federal code requirements and Energy conversation. 4 lecture/problems.

ECE 499/499A/499L Special Topics for Upper Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: permission of instructor. Instruction is by lecture, laboratory or a combination of both.

ENGINEERING TECHNOLOGY

G. Fred Sheets, Jr., *Interim Chair*
Donald E. Breyer
John S. Buhr
Edward V. Clancy
Gerald K. Herder
Fazal B. Kauser
Lyle B. McCurdy
Thomas O. Tice
Julie H. Wei

The Engineering Technology Department is accredited by Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TAC/ABET). Programs in Engineering Technology consist of integrated curricula designed to prepare graduates for technical careers in industry. They emphasize the application of engineering knowledge and methods to the solution of modern problems. Fundamentals and applications of engineering and management principles are reinforced in the laboratory and in the field.

High school graduates and community college transfer students with an aptitude in algebra, trigonometry, and the physical sciences, along with an interest in applications of new technology, are encouraged to apply to the program. Students desiring to major in Engineering Technology should have a capacity for science and mathematics, and incoming freshmen should have taken college preparatory courses in these disciplines in high school. Incoming transfer students should have completed two quarters of technical calculus and two quarters of college physics (with laboratory) prior to beginning the program at Cal Poly. All students should contact a program advisor to obtain assistance in developing their educational goals prior to actually starting their coursework. Each student will work with an advisor to coordinate a specific program of study. A minimum of 202 quarter units is required to complete the degree.

The Engineering Technology Department currently offers three degrees, and an incoming student will select from these choices:

CONSTRUCTION ENGINEERING TECHNOLOGY (CET)

This degree provides the student with a firm background in construction. Graduates may eventually work in any area of construction including building, heavy-civil, and residential. Construction Engineering Technology (CET) graduates work with owners, developers, architects, engineers (civil, mechanical, and electrical), building departments, governmental agencies, contractors, and subcontractors to build a variety of construction projects. Job titles include field engineer, project engineer, superintendent, as well as estimator, scheduler, and project manager.

Students receive training in construction materials, drafting, computer applications, construction surveying, structural design, construction equipment, estimating, scheduling, accounting, project management, safety and law.

The program has close ties with the construction industry. The student organization is the Construction Engineering and Management Association (CEMA). This includes the Associated General Contractors (AGC), Building Industry Association (BIA), and Construction Management Association of America. (CMAA). The CET program offers a number of construction scholarships, and students may apply for grants based on financial need and/or academic achievement.

ELECTRONICS AND COMPUTER ENGINEERING TECHNOLOGY (ECET)

In today's complex world, electronics, computers, and communications permeate every facet of our lives, and will become more so in the future. This growth can provide exciting, challenging, and rewarding career opportunities for forward-looking students in Electronics and Computer Engineering Technology. Engineering Technology is that part of the technological field which requires the application of scientific and engineering knowledge and methods combined with technical skills in support of engineering activities. It lies in the occupations spectrum between craftsman and the engineer at the end of the spectrum closest to the engineer. Engineering technologists are a member of the engineering team, consisting of the engineer, engineering technologist and engineering technician.

The engineering technologist is applications oriented, building upon a background of applied mathematics including the concepts and applications of calculus. Utilizing applied science and technology, technologists may work with engineers in utilizing applied design techniques to produce practical, workable and safe results quickly and economically; configure hardware from proven concepts.; install, operate, or manage complex technical systems, or provide customer engineering support, etc.

The BSECET program is an integrated four-year curriculum designed to prepare graduates for entry into industry as electronic engineering technologists. The lower division mathematics, science, and electrical and electronics coursework is designed to provide a strong foundation for the upper-division program. The upper-division coursework emphasizes digital electronics, computer hardware and software, communications electronics, and control and instrumentation. The program stresses the use of established electronic engineering analysis and design principles and applications for the solution of day-to-day technical problems currently found in industry.

ENGINEERING TECHNOLOGY (ET)

This degree is comprised four emphasis areas. Students may choose to concentrate in one of these areas which include: Mechanical, Manufacturing, Environmental and Aerospace emphasis areas. Internship during the senior year is encouraged for all students of this major.

The **Mechanical** emphasis area stresses the application and design of mechanisms and power transmission systems utilizing strength of materials, metallurgy, static's, dynamics, fluid mechanics, thermodynamics and heat transfer. Graduates may be involved in applied design, development, application, or production of mechanical devices and systems.

The **Manufacturing** emphasis area stresses technological competency and managerial skills in the economical utilization of raw material and resources through planning, selecting, and organization of manufacturing processes. Graduates may be involved with mass production, tooling, selection of machines and marketing of manufactured goods.

The **Environmental** emphasis area is a 2+2 program with community college Environmental Hazardous Materials & Technology Programs. The subject matter includes air and water quality, land restoration, hazardous material, and hazardous waste management and solid waste management. The hazardous material and waste management courses are available at community colleges. PETE (Partnership for Environmental Technology Education) has twenty-seven member schools in California and most, if not all, offer courses in hazardous material management. Cal Poly has a land lab and a regenerative study center as part of its campus. Graduates may work for industry, government agencies or engineering companies on environmental regulations and clean-up.

The **Aerospace** emphasis area is oriented toward the application of aerodynamics, propulsion, structures, and stability and control in the design of aircraft and aerospace structures. Graduates may be involved in applied design, development, production, and testing of airplane and aerospace systems.

The department's programs are oriented to help students achieve competency in applying current methods and design procedures developed by engineers to solve practical technical problems commonly found in industry; included in each program is instruction in applied sciences, drafting, computer usage, interpersonal relationships, oral and written communications, manufacturing processes, and the impact of technology upon the environment.

The faculty of the department is committed to helping students develop a strong sense of professionalism, high ethical standards and the pride that comes from accomplishment through technical competence. The department is also committed to helping students develop sound work habits, including neatness, completeness, and timeline; communicate effectively in written, oral, graphical, and mathematical form; and to be responsible for their own actions. We are committed to academic excellence and professional integrity.

CORE COURSES FOR ALL MAJORS*

Computer Applications for ET	ETT	101	(3)
Applied FORTRAN	ETT	110/120L	(4)
or Applied PASCAL Programming	ETT	115/125L	
or Applied C Programming	ETT	215/215L	
Applied Statics	ETT	210	(3)
Senior Seminar	ETT	460	(2)
Senior Project I	ETT	461	(2)
Senior Project II	ETT	462	(2)
Engineering Graphics	MFE	126/126L	(3)
College Physics	PHY	122	(3)
College Physics	PHY	123	(3)
College Chemistry	CHM	104	(3)
College Chemistry Lab	CHM	141L	(1)
Tech. Calculus II	MAT	131	(4)
Mathematics electives chosen from approved list			(8)

CONSTRUCTION ENGINEERING TECHNOLOGY*

Support Courses in Major

Construction Engineering	ETC	101	(3)***
Construction Drawings and Specifications	ETC	102/112L	(3)
Construction Surveying I	ETC	131/141L	(4)
Construction Surveying II	ETC	132/132L	(4)
Construction Materials	ETC	202	(3)
Construction Inspection	ETC	204	(3)
Electrical Installations	ETC	270/271L	(4)
Construction Accounting	ETC	279/289L	(3)
Construction Estimating I	ETC	304	(4)
Construction Estimating II	ETC	305	(4)
Structural Theory	ETC	311	(3)
Construction Equipment and Methods	ETC	312	(3)
Timber and Formwork Design	ETC	315	(4)
Steel Design	ETC	316	(3)
Concrete and Masonry Design	ETC	317	(3)
Construction Budgeting and Cost Control	ETC	401	(3)
Contracts and Specifications	ETC	402	(3)
Construction Safety	ETC	403	(3)
Construction Planning and Scheduling	ETC	405	(3)
Construction Organization and Management	ETC	406	(3)
Foundations and Soil Mechanics	ETC	411/421L	(4)
Concrete Mix Design	ETC	431/441L	(2)
Strength of Materials for ET	ETT	220/230L	(4)
Applied Fluid Mechanics	ETT	310/320L	(4)
Drafting Electives			(2)

ETx xxx**Technology Electives(14)
*** Substitutes for ETT 101

Total core units in major . . . . . (134)

ELECTRONICS AND COMPUTER ENGINEERING TECHNOLOGY*

Support Courses in Major

D-C Circuit Analysis	ETE	102/152L	(4)
A-C Circuit Analysis	ETE	103/153L	(4)
Electronic Devices and Circuits I	ETE	203/253L	(4)
Electronic Devices and Circuits II	ETE	204/254L	(4)
Electrical Circuit Analysis	ETE	210/260L	(4)
Introduction to Digital Logic	ETE	230/280L	(4)
Electronic Devices and Circuits III	ETE	305/355L	(4)
Applied Network Analysis	ETE	310	(4)
Linear Amplifier Circuits	ETE	314/364L	(4)
Digital Logic Systems	ETE	315/365L	(4)
Linear Integrated Circuits	ETE	318/368L	(4)
Computer Organization	ETE	340/390L	(4)
Communication Systems	ETE	435/485L	(4)
Electronic Manufacturing and PCB Fabrication	ETP	272/282L	(4)
Applied Dynamics	ETT	211	(3)
Materials Science for Electronics	ETT	337/337L	(4)
Technical Calculus III	MAT	132	(4)
Lower division technical elective**			(4)
Upper division technical elective**			(22)
Total core units in major			(134)

ENGINEERING TECHNOLOGY

Support Courses for Major

Graphics electives**	(6)
Technical electives**	(87)
Total core units in major	(134)

GENERAL EDUCATION COURSES

An alternate pattern from that listed here for partial fulfillment of Areas I, III, and IV available for students in this major is the **Interdisciplinary General Education (IGE)** Program. Please see the description of IGE elsewhere in this catalog.

Area 1:

Freshman English I	ENG	104	(4)
Advocacy and Argument	COM	204	(4)
Report Writing	COM	216	(4)

Area 2:

Technical Calculus I	MAT	130	(4)
College Physics	PHY	121	(3)
College Physics Lab	PHY	141L,142L,143L	(3)
Life Science	BIO	110	(3)
Statistical Methods in Engineering	STA	309	(3)

Area 3:

3a elective (Fine and Performing Arts)			(4)
3b elective (Philosophy and History)			(4)
3c elective (Literature and Foreign Languages)			(4)
3d Principles of Economics	EC	201 or 202	(4)
3e & 3f Political Sociology	SOC/PLS	390	(4)
3g elective (PSY 201 req'd. by major if MHR 318 in Area 5 is taken)			(4)

Area 4:

Introduction to American Government	PLS	201	(4)
US History	HST	202	(4)

Area 5:

Engineering Economics Analysis for ET	ETT	305	(4)
or Construction Economy	ETC	301	
Ethics and Engineering Decision Making	EGR	402	(4)
or Multicultural Organizational Behavior	MHR	318	
Total General Education units			(68)

Course Descriptions

All students in engineering and engineering technology curricula must satisfy ENG 104 prior to enrolling in any 300-level or higher course in the College of Engineering. Lecture and laboratory courses listed together are to be taken concurrently.

ETT 101 Computer Applications for Engineering Technology (3)

Introduction to engineering technology. Use of the personal computer for engineering problem-solving and documentation via software application packages. Research paper required. 3 lecture/problem sessions.

*Course counted in multiple categories. +One course of those indicated must satisfy the American Cultural.

* A 2.0 cumulative GPA is required in core courses including option courses for the major in order to receive a degree in this major. In addition, a minimum of 32 units must be upper-division specialty area courses and must be completed at Cal Poly Pomona.

** Select with advisor's approval

ETT 110/120L Applied FORTRAN/Laboratory (3/1)

Introduction to structured programming using FORTRAN 77. Programming problems applicable to engineering technology. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ETT 101, high school courses in trigonometry and college algebra.

ETT 115/125L Applied PASCAL Programming/Laboratory (3/1)

Introduction to computer programming using PASCAL. 3 lecture/ problems, 1 three-hour laboratory. Prerequisites: ETT 101, high school courses in Trigonometry and College Algebra.

ETT 200 Special Problems for Lower Division Students (1-2)

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

ETT 201/251L Electrical Technology/Laboratory (3/1)

Introduction to operation and application of basic electrical measuring instruments. D.C. and A.C. circuit applications involving resistance, inductance and capacitance. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: PHY 123. Not open to ET students in the Electronics and Computer option.

ETT 210 Applied Statics (3)

Introduction to the basic concepts of mechanics emphasizing the action of forces on rigid bodies and the response of those bodies to the applied forces. Methods for logical solutions to engineering problems are stressed. 3 lecture/problems. Prerequisite: "University level Trigonometry and Algebra," PHY 121.

ETT 211 Applied Dynamics (3)

Application of the theory of motion of rigid bodies with acceleration from applied forces. Emphasis on problems in which those bodies can be considered as non-rotating. Introduction to plane motion with rotation. Uses analytical methods. 3 lecture/problems. Prerequisite: ETT 101, ETT 210, MAT 131.

ETT 215/215L C Programming for Technology/Laboratory (3/1)

Introduction to structured programming using ANSI C. Programming problems applicable to engineering technology. 3 lecture/problems. 1 three-hour laboratory. Prerequisites: ETT 101 or equivalent, ETT 110.

ETT 220/230L Strength of Materials for Engineering Technology/Laboratory (3/1)

Stress-strain diagrams; tensile, compressive and shear stresses; working stresses and factors of safety; torsional stress and angular deformation in circular shafts; beam analysis, shear and moment diagrams, bending stress, shear stress, and beam deflections; column analysis; bolted and riveted connections in direct shear and eccentric loading; thin-walled pressure vessels; thermal stresses; combined stresses. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ETT 210, MAT 131.

ETT 234/234L Materials Joining/Laboratory (1/1)

Methods of materials joining used in modern industry as applied to metals and plastics. Introduction to evaluation methods. 1 lecture, 1 three-hour laboratory.

ETT 270, 470 Engineering Technology Internship (3) (3)

Specially assigned or approved on-the-job work activities in industry or other institutions related to student's educational program of studies. Formal report required. Prerequisites: full-time engineering technology related employment. Advance approval by internship coordinator required via a written proposal, and a letter of intent from the sponsoring company. Each course may be repeated once: maximum credit limited to 12 units.

ETT 299/299A/299L Special Topics for Lower Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Permission of instructor. Instruction is by lecture, laboratory, or a combination of both.

ETT 305 Engineering Economics Analysis for Engineering Technology (4)

Principles and techniques of economics analysis of engineering and manufacturing projects. Costs and estimation, time value of money, economic evaluation criteria, basic comparative models, and replacement analysis. Consideration of income taxes, risk, and intangibles. Research papers and independent study required. 4 lecture/problems. Prerequisites: COM 216, EC 201 or EC 202.

ETT 307/307L Engineering Materials (3/1)

Concepts of the structure and properties of materials and their relevance to industrial applications, properties of metals, ceramics, plastics, composites, and semiconductors. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: CHM 104; ETT 220; MAT 130; PHY 121.

ETT 310/320L Applied Fluid Mechanics/Laboratory (3/1)

Applied principles of fluid flow. Properties of fluids. Fluid impulse and momentum. Viscous flow in pipes and open channels. 3 lecture/problems; 1 laboratory. Prerequisites: ETT 210; MAT 131; PHY 121.

ETT 337/337L Materials Science for Electronics/Laboratory (3/1)

Chemical and physical properties of semiconductor materials and specific solid-state devices. Manufacturing processes of solid state devices. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ETE 204, CHM 104, PHY 123, MAT 131.

ETT 400 Special Problems for Upper Division Students (1-2)

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

ETT 460 Undergraduate Seminar (2)

Seminar discussion of new developments, policies, practices and procedures. Preparation and oral presentation by each student of his/her senior project, 2 hours seminar/discussion per week. Prerequisite: Senior standing, ETT 101, COM 204, COM 216, satisfaction of GWT.

ETT 461, 462 Senior Project I, II (2) (2)

Selection and completion of a project under faculty supervision. Projects typical of problems which graduates must solve in their field of employment. Presentation of project in a formal report. Minimum 120 hours total time. Prerequisite: ETT 460, senior standing, and consent of E.T. Department Chair.

ETT 499/499A/499L Special Topics for Upper Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: permission of instructor. Instruction is by lecture, laboratory, or a combination of both.

ETC 101 Introduction to Construction Engineering and Microcomputers (3)

An introduction to construction. An overview of the construction program, the scope of the field of construction and the responsibilities of the construction engineer. Introduction to microcomputers and applications. 3 lecture/problems. Prerequisites: High school courses in trigonometry and college algebra.

ETC 102/112L Construction Drawings and Specifications/Laboratory (1/2)

A study of the format, guidelines and practices of Construction Drawings and Specifications for buildings and heavy construction. Architectural, civil, structural, mechanical, electrical, plumbing and landscape drawings. Drainage and grading plans. 1 lecture/problems, 2 three-hour laboratories. Prerequisites: MFE 121L.

ETC 131/141L Construction Surveying I/Laboratory (2/2)

Fundamental surveying methods as applied to construction layout. Use of electronic transit and automatic level for location and construction operations. Vertical and horizontal control. 2 lecture/problems, 2 three-hour laboratories. Prerequisite: High school courses in trigonometry and college algebra.

ETC 132/132L Construction Surveying II/Laboratory (2/2)

Profile levels, cross-section and highway slope-staking for matrix earthwork calculations and cut/fill distribution. Horizontal and vertical highway curves. Topographic surveys, computer application land mapping. Construction layout of buildings, roads and utilities. 2 lecture/problems, 2 three-hour laboratories. Prerequisite: ETC 131/141L.

ETC 202 Construction Materials (3)

Properties of materials used in building and heavy construction. Methods of fabrication and installation of construction materials. Introduction to industry standards and specifications. 3 lecture/problems.

ETC 204 Construction Inspection (3)

Introduction to construction inspection, functions, responsibilities, authority and technical requirements related to heavy and building construction. 3 lecture/problems. Prerequisites: ETC 102.

ETC 270/271L Electrical Installations/Laboratory (3/1)

Fundamentals of electrical equipment and installations as related to the construction industry. Electrical wiring, transformers, machines, illumination, heating, wiring codes and specifications. 3 lecture/ problems, 1 three-hour laboratory. Prerequisites: PHY 123, high school courses in trigonometry and college algebra. Not open to ECET majors.

ETC 279/289L Construction Accounting/Laboratory (2/1)

Fundamentals and practices of financial and management accounting in construction industry, including accounting processes, internal control, cost elements, overhead allocation and financial reports. 2 lecture/problems, 1 three-hour laboratory.

ETC 299/299A/299L Special Topics for Lower Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Permission of instructor. Instruction is by lecture, laboratory, or a combination of both.

ETC 301 Construction Economy (4)

Fundamental principles and basic techniques of cost analysis of equipment and facility ownership, retirement and replacement, considering the time value of money, income taxes and risk. 4 lecture/problems. Prerequisite: EC 201 or 202.

ETC 304 Construction Estimating I (4)

Fundamentals of building construction estimating procedures considering both quantity surveying and pricing of labor, materials, and equipment costs. 4 lecture/problems. Prerequisites: Junior standing, ETC 102 and ETC 202

ETC 305 Construction Estimates II (4)

Fundamentals of heavy construction estimating procedures considering both quantity survey and pricing. 4 lecture/problems. Prerequisite: ETC 304.

ETC 311 Structural Theory (3)

Introduction to structural systems used in construction projects. Design loads. Analysis of statically determinate beams, frames, and trusses for forces and deflections. Computer applications. Introduction to statically indeterminate structures using moment distribution. 3 lecture/problems. Prerequisite: ETT 202, MAT 131, PHY 121.

ETC 312 Construction Equipment and Methods (3)

Construction procedures, job planning layout and scheduling, selection and application of construction equipment to building and heavy construction projects. 3 lecture/problems. Prerequisite: Junior standing.

ETC 315 Timber & Formwork Design (4)

Properties of wood. Design loads. Design of structural elements including beams, columns, horizontal diaphragms, and shearwalls. Connection design. Application of timber design to the construction project including the design of concrete formwork and falsework for slabs, beams, columns and walls. 4 lecture/problems. Prerequisite: ETC 311.

ETC 316 Steel Design (3)

Design of structural steel elements including tension members, columns, beams, and beam-columns using allowable stress design (ASD). Design of welded and bolted connections. AISC specifications. Introduction to load and resistance factor design (LRFD). 3 lecture/problems. Prerequisite: ETC 311.

ETC 317 Concrete and Masonry Design (3)

Design of reinforced concrete and reinforced masonry structural elements including beams, T-beams, slabs, columns, walls, retaining walls and footings. ACI specifications. Design of reinforced masonry beams, lintels, walls and retaining walls. 3 lecture/problems. Prerequisite: ETC 315.

ETC 401 Construction Budgeting and Cost Control (3)

Methods and procedures used in planning, budgeting, scheduling and cost control related to construction projects. Methods of monitoring, trending, forecasting and appraisal of project cost via manual and computer techniques. 3 lecture/problems. Prerequisites: ETC 279, ETC 405.

ETC 402 Contracts and Specifications (3)

Basic principles and detailed review of design drawings and contract documents, including plans, specifications and agreements involved in the construction of facilities. 3 lecture/problems. Prerequisite: Senior standing, COM 216, ETC 102.

ETC 403 Construction Safety (3)

Logical problem solving using safety engineering in construction, considering safety legislation, OSHA. Safety programs, accident prevention and public safety. 3 lectures. Prerequisite: Senior standing, corequisite: ETC 312.

ETC 405 Construction Planning and Scheduling (3)

Methods and procedures used in planning and scheduling construction projects using graphic charts and PERT/CDM networks. Resource allocations, leveling and cost curves. Application of manual and computer network systems. 3 lecture/problems. Prerequisite: ETC 305.

ETC 406 Construction Organization and Management (3)

Theory and techniques of construction management and the general organizational structure of a contracting firm. Contractor's policies and procedures regarding the legal, financial, marketing, and personnel management as well as the everyday operations of a construction company and/or project. 3 lecture/problems. Prerequisite: ETC 305.

ETC 411/421L Foundations and Soil Mechanics/Laboratory (3/1)

Selection and methods of installation of foundations and other soil-supported structures. Footings, piles, caissons, retaining structures, soil embankments and fills. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: ETC 311.

ETC 431/441L Concrete Mix Design/Laboratory (1/1)

Theory and practice of concrete materials and the methods utilized in the mix design, production, placement and testing of structural concrete. 1

lecture/problem, 1 laboratory. Prerequisites: Senior standing, ETC 202, PHY 121.

ETC 499/499A/499L Special Topics for Upper Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Permission of instructor. Instruction is by lecture, laboratory, or a combination of both.

ETE 102/152L D-C Circuit Analysis/Laboratory (3/1)

Principles of electric circuit elements including resistance, capacitance and inductance; magnetism. Basic d-c network theorems. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: High school courses in trigonometry and college algebra.

ETE 103/153L A-C Circuit Analysis/Laboratory (3/1)

Phasor analysis in a-c circuits. Basic a-c circuit theorems. D-C Transients. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ETE 102.

ETE 203/253L Electronic Devices and Circuits I/Laboratory (3/1)

Introduction to the theory of semiconductor junction devices. Characteristics and operation of diode and bipolar junction transistors; d-c characteristics, biasing, and d-c stability. Basic device applications. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ETE 103.

ETE 204/254L Electronic Devices and Circuits II/Laboratory (3/1)

Analysis of single stage BJT amplifier circuits. Introduction to field effect transistor devices and analysis of single stage FET amplifier circuits. Small signal analysis, gain calculations, input/output impedance calculations, stability analysis. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ETE 103/153L and 203/253L.

ETE 210/260L Electrical Circuit Analysis/Laboratory (3/1)

Frequency response in RLC circuits; transfer functions, Bode plots, filters. Introduction to 3-phase circuits. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ETE 103; MAT 131.

ETE 215/265L Electronic Circuits/Laboratory (4/1)

Electronic circuit analysis involving single stage amplifiers, bipolar and field effect transistors. D.C. stability design and analysis, small signal parameters and A.C. equivalent circuits. Primarily for transfer students who have a basic knowledge of transistors. 4 lecture/problems, 1 three-hour laboratory. Prerequisite: College-level course in electronic devices, high school courses in trigonometry and college algebra, PHY 123.

ETE 230/280L Introduction to Digital Logic/Laboratory (3/1)

Characteristics and applications of basic building blocks of digital systems. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: ETE 204/254L.

ETE 299/299A/299L Special Topics for Lower Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisites: Permission of instructor. Instruction is by lecture, laboratory, or a combination of both.

ETE 305/355L Electronic Devices and Circuits III/Laboratory (3/1)

BJT and FET high frequency models. Frequency effects of coupling, bypass, and interelectrode capacitance upon gain and input-output impedance of single stage BJT and FET amplifiers. Bode plots. Differential amplifiers. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ETT 101; ETE 204, 210; MAT 131.

ETE 310 Applied Network Analysis (4)

Transient Analysis, transfer functions, frequency response. Computer methods utilized. 4 lecture/problems. Prerequisites: ETT 101; ETE 210; MAT 132.

ETE 314/364L Linear Amplifier Circuits/Laboratory (3/1)

Analysis of multistage and large signal amplifiers. Frequency response. Ideal and non-ideal negative feedback amplifiers and their characteristics. Oscillators. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ETE 305.

ETE 315/365L Digital Logic Systems/Laboratory (3/1)

Digital circuit analysis and design using registers and counters. Sequential networks. A-D and D-A conversions. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: ETE 230/280L.

ETE 318/368L Linear Integrated Circuits/Laboratory (3/1)

Characteristics of operational amplifiers. Basic applications and classical circuits. Frequency response. D-C and a-c errors and compensation. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ETE 314.

ETE 319/369L Linear Circuit Applications/Laboratory (3/1)

Practical applications of currently available monolithic circuit devices in linear and digitally-related linear electronic circuits. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: ETE 318.

ETE 321/371L Electronic Devices and Systems/Laboratory (3/1)

A study of linear and digital electronic devices, circuits, and instruments as related to measurement, amplification, and control of electromechanical systems. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: PHY 123, ETT 201. Not open to ETE majors.

ETE 340/390L Computer Organization/Laboratory (3/1)

Analysis and design of basic computer system architecture. 3 lecture/ problems, 1 three-hour laboratory. Prerequisite: ETE 315/365L.

ETE 360/360L Electronic Systems Reliability/Laboratory (3/1)

Theory of electronic troubleshooting, special testing methods, failure diagnosis system reliability. Component operational theory. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ETE 318; course in fundamentals of statistics.

ETE 409/459L Feedback Systems Technology/Laboratory (3/1)

Introduction to electro-mechanical systems with feedback. Frequency and time response, stability and closed-loop system characteristics, industrial controllers and tuning. Use of a computer simulation package. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ETT 101, and ETE 310.

ETE 420/420L Electronic Test Instrumentation/Laboratory (3/1)

Fundamentals of electronic test instrumentation. Theory and function of principal types of laboratory electronic test equipment such as electronic meters, oscilloscope, signal generators, counters, laboratory potentiometers and bridges, and various other analyzing test equipment for DC, AF, and RF voltages and currents. 3 lecture/ problems, 1 three-hour laboratory. Prerequisites: ETE 318; course in fundamentals of statistics.

ETE 435/485L Communication Systems/Laboratory (3/1)

The study of periodically gated, amplitude, single sideband, and frequency modulation methods involved in communications systems. Receivers and telemetry systems. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ETE 314, MAT 132.

ETE 437/487L RF Measurements/Laboratory (3/1)

Electronic measurement equipment and techniques for measurements at radio frequencies of such quantities as power, impedance, standing wave ratio, frequency, voltage, and current, Smith Charts, impedance matching, radio receiver measurements, antenna measurements. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ETE 435; MAT 132.

ETE 438/488L Microwave Techniques/Laboratory (3/1)

Microwave safety, generation, transmission, wave guides, wave guide components and measurements. Microwave measurement systems and techniques. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ETE 437.

ETE 442/492L Digital Data Communications/Laboratory (3/1)

Digital communication concepts and techniques; information codes; error detection codes; line control procedures; modes of transmission; concentrators and distributed intelligence. 3 lecture/problems. 1 three-hour laboratory. Prerequisite: ETE 444.

ETE 444/494L Microcomputer Programming/Laboratory (3/1)

Software model of the 8088 microprocessor and the IBM PC. Machine-language and assembly-language programming; use of various 8088 peripheral devices. 3 lecture-problems, 1 three-hour laboratory. Prerequisites: ETT 110, ETE 340/390L.

ETE 445/495L Microprocessor Applications/Laboratory (3/1)

System application of microprocessors with emphasis on the interfacing of VLSI chips. Interface standards of computer industry. 3 lecture/ problems, 1 three-hour laboratory. Prerequisite: ETE 340/390L.

ETE 446/456L Switching Circuits and Devices/Laboratory (3/1)

Analysis of circuits operating in a switched mode. Waveshaping, timing, and logic families. Special devices, A-D and D-A converters. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ETT 101; ETE 230, 305; MAT 131.

ETE 455 Laser Technology (4)

Introduction to lasers. Basic laser theory. Laser modulation and detection. Characteristics of solid, liquid, gaseous and semiconductor lasers. Laser technology applied to various fields. 4 lecture/problems. Prerequisites: ETE 314; ETT 307; PHY 123; MAT 132.

ETE 499/499A/499L Special Topics for Upper Division Students (1–4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Permission of instructor. Instruction is by lecture, laboratory, or a combination of both.

ETM 299/299A/299L Special Topics for Lower Division Students (1–4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Permission of instructor. Instruction is by lecture, laboratory, or a combination of both.

ETM 306 Applied Thermodynamics (4)

Applications of fundamental concepts of work, heat, energy. Basic power and refrigeration cycles, and reciprocating machines. First and second law of thermodymanics as applied to engineering technologist. Use of generalized charts and handbooks in solving thermodynamic problems. 4 lecture/problems. Prerequisites: ETT 211; ETT 310, MAT 131.

ETM 308 Applied Heat Transfer (3)

Survey of the application of empirical and algebraic equations used in the solution of practical and laboratory type of heat transfer problems. Includes three modes of heat transfer: conduction, convection, and radiation. 3 lecture/problems. Prerequisite: ETM 306.

ETM 315/325L Machine Elements/Laboratory (3/1)

Practical application of the fundamentals of mechanics and strength of materials to the design of machine elements with emphasis on computer aided design solution-problems. 3 lecture/problems, 1 three hour lab. Prerequisites: ETT 110, 220; PHY 121.

ETM 320/340L Power Transmission Systems/Laboratory (3/1)

Introduction to the elements of power transmission systems, including shafting, couplings, belts, chains, gears, clutches, fluid couplings and fluid pumps and motors. Theory and operation of power transmission systems composed of above elements. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: ETM 315.

ETM 324/344L Applied Mechanisms/Laboratory (3/1)

A study of the elements of mechanisms; cams, gears, kinematics. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ETT 211; MFE 121L; MAT 131; PHY 121.

ETM 330/330L Instrumentation Applications/Laboratory (3/1)

Application of engineering measurement techniques, pressure gages, calibration and servicing, strain gages and strain indicators, pressure transducers and instrumentation, thermocouples and instrumentation. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: PHY 123; high school courses in trigonometry and college algebra.

ETM 334 Applied Heating and Air Conditioning (4)

Thermal environmental requirements for human habitation. Psychrometrics. Building heating and cooling loads. Air-handling equipment. 4 lecture/problems. Prerequisite: ETM 306.

ETM 335/345L Heating and Air Conditioning/Laboratory (3/1)

Heating equipment; refrigeration systems and equipment. Design of a complete system of compatible components for the control of thermal environment. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: ETM 334.

ETM 410/420L Internal Combustion Engines/Laboratory (2/1)

Theory and performance of internal combustion engines including spark ignition, diesel and gas turbine. Operation of carburetion, ignition and cooling systems. Selection and rating of fuels. 2 lecture/problems, 1 three-hour laboratory. Prerequisite: ETM 306.

ETM 499/499A/499L Special Topics for Upper Division Students (1–4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Permission of instructor. Instruction is by lecture, laboratory, or a combination of both.

ETP 272/282L Electronic Manufacturing and PCB Fabrication/Laboratory (3/1)

Manufacturing and fabrication processes associated with the electronics industry. High-reliability testing. Bonding, joining, cabling techniques. PCB artwork and manufacturing techniques. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ETE 204, MFE 121L, 210L.

ETP 276/286L Production Control/Laboratory (3/1)

Principles of planning and controlling production activities; product development, forecasting, scheduling and loading, routing, material control, dispatching, progress reporting and corrective action. Design of production control systems. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: MFE 221, 230.

ETP 299/299A/299L Special Topics for Lower Division Students (1–4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite:

Permission of instructor. Instruction is by lecture, laboratory, or a combination of both.

ETP 300 Applied Total Quality Management (3)

Study of technological and management specialization in Total Quality Management within the engineering environment. An overview of TQM as it relates to quality leadership within an organization. 3 lecture/problems. Prerequisite: Junior standing.

ETP 302 Industrial Safety (3)

An introduction to the problems of industrial safety. Emphasis upon accident prevention and control. Covers state and federal OSHA regulations and implications of the Williams-Steiger Occupational Safety and Health Act of 1970. 3 lecture/problems. Prerequisite: Junior standing.

ETP 305 Manufacturing Engineering Technology Supervision (3)

A study of technological and professional specialization in engineering supervision. Manufacturing engineering as it relates to the translation of ideas into marketable products. Emphasis is placed upon technological and professional specialization in engineering supervision within manufacturing engineering. 3 lecture/problems. Prerequisite: Junior standing, ETT 305.

ETP 355/355L Production Machining (2/1)

Precision machining operations with emphasis on methods used in mass production. Cutting tools and fluids used in production machining. Selection of machines and tooling for production operation. 2 lecture/problems, 1 three-hour laboratory. Prerequisite: MFE 222.

ETP 371/391L Production and Facilities Planning/Laboratory (3/1)

Concepts and methods of planning engineering projects, production programs, and plant layouts and facilities. Loading and scheduling, product and process planning, facilities analysis, layout planning, and materials analysis. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: ETP 276, ETT 305.

ETP 375 Quality Assurance (3)

Quality planning, analysis and control. Inspection systems, process control techniques, and acceptance sampling methods. Use of statistical and other methods for assuring desired quality levels. 3 lecture/problems. Prerequisite: Course in fundamentals of statistics.

ETP 377 Manufacturing Systems Engineering Methods (3)

Analysis, application and computation of statistical methods and mathematical programming procedures as applied to engineering and industrial systems. Use of computer and software packages. 3 lecture/problems. Prerequisites: ETT 110, MAT 131, course in fundamentals of statistics.

ETP 405 Manufacturing Engineering Material Management (3)

Problems of manufacturing engineering material management referenced to the total integrated system of converting raw material into a finished product. 3 lecture/problems. Prerequisite: Senior standing, ETT 305.

ETP 407 Manufacturing Engineering Value Analysis (3)

Selected topics and problems utilizing value analysis as a tool for determining the proper relationship between price, cost, and value received. An integration of technical and economical factors of quality. 3 lecture/problems. Prerequisite: Senior standing, ETT 305.

ETP 408 Manufacturing Control (3)

Problem of the various phases of starting up, operating, and maintaining an owner-managed manufacturing company. Emphasis on economic justification of alternate courses of action open to the manufacturing entrepreneur. 3 lecture/problems. Prerequisite: Senior standing, ETT 305.

ETP 437/437L, 438/438L Nondestructive Evaluation I/Laboratory, II/Laboratory (1/1) (1/1)

Discontinuities in materials and their detection. Process principles and equipment for penetrant, magnetic particle, ultrasonic, radiographic and eddy current methods. Reference to other processes. Radiation health physics. 1 lecture/problem, 1 three-hour laboratory. Prerequisite: ETT 307.

ETP 499/499A/499L Special Topics for Upper Division Students (1–4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Permission of instructor. Instruction is by lecture, laboratory, or a combination of both.

INDUSTRIAL AND MANUFACTURING ENGINEERING

Phillip R. Rosenkrantz, *Chair*
Kamran Abedini
Farouk Darweesh
John D. O'Neil
Donald G. Zook
Klaus D. Bauch
Biman K. Ghosh
Abdul B. Sadat

The department offers two degree programs, one in Industrial Engineering and one in Manufacturing Engineering. Each program prepares the students for both engineering practice and for graduate study. The Industrial Engineering major is concerned with the most effective methods of utilizing and integrating people, materials, and equipment in both production and service organizations. The Manufacturing Engineering major is concerned with the most effective ways of designing and developing manufacturing systems. It is possible to major in both Industrial Engineering and Manufacturing Engineering. Interested students should contact their academic advisors or the department office.

Students desiring to major in either Industrial or Manufacturing Engineering should have a particularly high aptitude for science and mathematics, and incoming freshmen should have taken substantial college preparatory courses in these disciplines in high school. Incoming transfer students should have completed at least one year of college calculus and one year of college physics (with laboratory) prior to beginning the program at Cal Poly. The community college student planning to transfer into this department should consult a school counselor or this department to determine which courses meet the program requirements.

Graduates of the program are prepared to do productive work in their first jobs as well as to grow with their profession throughout their engineering career. The curriculum is designed to prepare a student for direct entry into the engineering profession and for graduate school.

Total Quality Management Minor

The Total Quality Management (TQM) Minor may be taken by students having any major in the University, but it is particularly appropriate for students majoring in either Industrial Engineering or Manufacturing Engineering. The minor is intended to allow students to gain the knowledge and skills necessary for effective application of quality management techniques in manufacturing, service and not-for-profit organizations. The TQM Minor will help fill the need, especially for graduates in engineering and business, who are trained in the concepts, techniques, tools and methods of analysis used for the continuous improvement of product, service or process quality. Computer-based approaches are used whenever they are available and appropriate. A full description of the minor is included in the "University Programs" section of this catalog.

Industrial Engineering

Industrial Engineering is a dynamic profession with credible growth and increasing importance. Industrial engineers use engineering principles to develop integrated systems of people, materials, and equipment. As problem solvers, industrial engineers are equipped with practical and scientific tools to tackle complex industrial problems and to increase the productivity of workers, capital, and facilities. Industrial engineers are educated to provide valuable service to management in questions regarding the best use of people, materials, equipment, and energy. They are the engineers who design and implement productivity and quality improvement methods for industry.

The accredited industrial engineering curriculum provides a broad background in humanities and social sciences, mathematics, physical sciences, engineering science, analysis, design, and systems. It provides a good balance between the traditional industrial engineering subjects and the most recent developments in the discipline. Industrial engineering students take courses in work analysis and design, process design, human factors, facilities planning and layout, engineering economic analysis, production planning and control, systems engineering, computer utilization and simulation, operations research, quality control, automation, robotics, and productivity engineering.

The program is designed to provide the student with a good foundation of basic concepts and principles in addition to applied engineering techniques. The department and university laboratories and equipment, including computers, are integrated into the coursework throughout the program.

Industrial Engineering students are encouraged to join the Cal Poly Pomona chapter of the Institute of Industrial Engineers. Eligible students may be invited to join the student chapter of Alpha Pi Mu, the industrial engineering honor society. There are also student chapters of the American Foundrymen's Society, the Society of Manufacturing Engineers and the American Society for Quality Control.

CORE COURSES FOR MAJOR*

(Required of all students)

Fundamentals of Human Factors Engr	IE	225/L	(4)
Indus Engr Math Anal	IE	311	(3)
Ele of Ind Engr Sys	IE	327/L	(4)
Oper Research I	IE	416	(4)
Oper Research II	IE	417	(4)
System Simulation	IE	429/L	(4)
Operations Planning and Control	IE	436/L	(3)
Ind & Mfg Engg Fund	IME	112	(3)
Ind & Mfg Engg Comp/Lab	IME	113/L	(2)
Work Analysis and Design	IME	224/L	(4)
Indus Costs and Controls	IME	239	(3)
Production Plng and Control	IME	326	(3)
Facilities Planning, Layout & Design	IME	331/L	(4)
Quality Control by Stat Meth	IME	415	(4)
Senior Project	IME	461	(2)
Senior Project	IME	462	(2)
Industrial Engr electives (From approved list)			(6)
Mfg. Sys. Processes	MFE	201/L	(4)
C for Engineers	ECE	114	(3)

SUPPORT AND ELECTIVE COURSES

(Required of all students)

Gen Chem	CHM	111/151L	(4)
Gen Chem	CHM	112/152L	(3)
Elem Elec Engr	ECE	231/251L	(4)
Elec Inst & Con	ECE	333/383L	(4)
Engineering Prob & Stat	IME	312	(3)
Undergrad Seminar	IME	460	(2)
Analytical Geometry & Calculus	MAT	115	(4)
Analytical Geometry & Calculus	MAT	116	(4)
Calc of Sev Var	MAT	214	(3)
Calc of Sev Var	MAT	215	(3)
Differential Eqm	MAT	216	(4)
Vector Statics	ME	214	(3)
Vector Dynamics	ME	215	(4)
Strength Matls	ME	218	(3)
Strength Matls	ME	219	(3)
Engineering Graphics I	MFE	126/L	(3)
Intro. Comp. Integ. Mfg.	MFE	450/L	(4)
Matls Sci & Engr	MTE	207	(3)
General Physics	PHY	132	(3)
General Physics	PHY	133	(3)

* A 2.0 cumulative GPA is required in core courses including option courses for the major in order to receive a degree in this major.

GENERAL EDUCATION COURSES

An alternate pattern from that listed here for partial fulfillment of Areas 1, 3, and 4 available for students in this major is the Interdisciplinary General Education (IGE) Program. Please see the description of IGE elsewhere in this catalog.

(Required of all students)

Area 1:			
Freshman English I	ENG	104	(4)
Advocacy and Argument	COM	204	(4)
Report Writing	COM	216	(4)
Area 2:			
Analytical Geometry & Calculus	MAT	114	(4)
Var. & Stat. Engg. Design	IME	301	(3)
or Stat. Meth. Engg.	STA	309	
Life Science	BIO	110	(3)
General Physics	PHY	131/151L, 152L, 153L	(6)
Area 3:			
3A Elective+			(4)
3B Elective+			(4)
3C Elective+			(4)
Principles of Economics	EC	201	(4)
or EC 202			
** Political Sociology	SOC/PLS	290	(4)
3G Elective+			(4)
Area 4:			
Intro to American Government	PLS	201	(4)
U.S. History	HST	202	(4)
Area 5:			
Ethics & Engr Dec Making	EGR	402	(4)
Capital Allocation Theory	EGR	403	(4)

**Course counted in multiple categories. +One course of those indicated must satisfy the American Cultural Perspectives requirement. Underlined courses satisfy both major and G.E. requirements.

Manufacturing Engineering

The Manufacturing Engineering program contains a unique, well balanced curriculum designed to prepare the student for a fast and productive entry into today's complex manufacturing environments. The program is the only one of its kind in California and is well received by the industrial community. Manufacturing engineers plan, develop, and optimize the process and systems of production. They improve manufacturing productivity by developing better methods of assembling, testing, and fabricating systems and products.

Manufacturing engineering students are given a solid foundation in production processes and techniques, properties of materials, computers and automation management, and professional communication. These building blocks are then combined and studied as manufacturing systems and then related to the most recent manufacturing technologies. Integrated sequences of courses are provided in: (1) Engineering Design Graphics; (2) Materials and Manufacturing Processes; (3) Process, Assembly and Product Engineering; (4) Manufacturing Productivity and Quality; and (5) Manufacturing Integration Methods and Systems Development. What makes the manufacturing engineering program unique is the fact that it is designed to help the students apply what they have learned through lab assignments, projects, field trips, trade shows, and co-op work. Students get lab experience in metal removal processes, forming and assembly, computer, numerical control, robotics, and CAD/CAM.

Manufacturing engineering graduates are in demand by all types and sizes of manufacturing companies because of their diversified training in traditional as well as new areas of manufacturing knowledge. The rapid growth of new technologies in computer-integrated manufacturing, robotics, lasers, artificial intelligence, and composites have opened a whole new world of opportunities for manufacturing engineers. The trend in industry is toward utilizing design engineers and manufacturing engineers as a team in order to produce more economical and functional products.

Manufacturing engineering students are encouraged to join the student chapter of the Society of Manufacturing Engineers. There are also student chapters of the American Foundrymen's Society, the Institute of Industrial Engineers, and the American Society for Quality Control.

CORE COURSES FOR MAJOR*

(Required of all students)

Ind & Mfg Engg Fund	IME	112	(3)
Ind & Mfg Engg Comp/Lab	IME	113/L	(2)
Industrial Costs and Controls	IME	239	(3)
Production Planning and Control	IME	326	(3)
Facilities Planning, Layout & Design	IME	331/L	(4)
Quality Control by Statistical Methods	IME	415	(4)
Senior Project	IME	461	(2)
Senior Project	IME	462	(2)
Engg Graphics I	MFE	126/L	(3)
Mfg Processes I-Material Removal	MFE	221/L	(3)
Engg Graphics II	MFE	226/L	(3)
Mfg Processes II-Forming, Casting, & Joining	MFE	230/L	(3)
Measurement & Methods/Lab	MFE	320/L	(4)
Production Engg/Lab	MFE	326/L	(4)
Principles of Numerical Control	MFE	350/L	(3)
CAD/CAM/Lab	MFE	375/L	(4)
Manufacturing Operations Analysis	MFE	421	(3)
Intro CIM	MFE	450/L	(4)
Metal Working Theory & Applications	MFE	465	(3)
Adv CAM Systems/Lab	MFE	476/L	(4)
Manufacturing Electives (selected with advisor's approval)			(5)

SUPPORT AND ELECTIVE COURSES

(Required of all students)

General Chemistry	CHM	111/151L	(4)
General Chemistry	CHM	112/152L	(3)
Elem Elec Engr	ECE	231/251L	(4)
Elec Inst & Control	ECE	333/383L	(4)
Engineering Prob & Stat	IME	312	(3)
Undergraduate Seminar	IME	460	(2)
Analytical Geometry & Calculus	MAT	115	(4)
Analytical Geometry & Calculus	MAT	116	(4)
Calc of Sev Var	MAT	214	(3)
Calc of Sev Var	MAT	215	(3)
Differential Eqn	MAT	216	(4)
Vector Statics	ME	214	(3)
Vector Dynamics	ME	215	(4)
Strength of Matls	ME	218	(3)
Thermodynamics	ME	301	(4)
Fluid Mechanics	ME	311	(3)
Matls Sci & Engr	MTE	207	(3)
General Physics	PHY	132	(3)
Gen Physics	PHY	133	(3)

GENERAL EDUCATION COURSES

An alternate pattern from that listed here for partial fulfillment of Areas 1, 3, and 4 available for students in this major is the Interdisciplinary General Education (IGE) Program. Please see the description of IGE elsewhere in this catalog.

(Required of all students)

Area 1:			
Freshman Comp	ENG	104	(4)
Advocacy and Argument	COM	204	(4)
Report Writing	COM	216	(4)
Area 2:			
Analytical Geometry & Calculus	MAT	114	(4)
Life Science	BIO	110	(3)
General Physics	PHY	131/151L, 152L, 153L	(6)
Var. & Stat. Engg. Design	IME	301	(3)
or Stat. Meth. Engg	STA	309	

Area 3:

3a Elective+			(4)
3b Elective+			(4)
3c Elective+			(4)
3d Principles of Economics or EC 202	EC	201	(4)
**3e & 3f Political Sociology	SOC/PLS		390(4)
3g Elective+			(4)

Area 4:

Intro to American Government	PLS	201	(4)
U.S. History	HST	202	(4)

Area 5:

Ethics & Engr Dec Making	EGR	402	(4)
Capital Allocation Theory	EGR	403	(4)

*Course counted in multiple categories. +One course of those indicated must satisfy the American Cultural Perspectives requirement. Underlined courses satisfy both major and G.E. requirements.

Course Descriptions

All students in engineering and engineering technology curricula must satisfy ENG 104 prior to enrolling in any 300-level or higher course in the College of Engineering. Lecture and laboratory courses listed together are to be taken concurrently.

IE 225/225L Fundamentals of Human Factors Engineering/Laboratory (3/1)

Study of human physiological, biomechanical, and psychological characteristics and how they influence engineering and design of equipment, machines, products, facilities, tools, and environments. 3 lecture/problems, 1 three-hour laboratory.

IE 311 Industrial Engineering Mathematical Analysis (3)

Application of linear equations, matrices, and determinants to the solution of industrial engineering problems. Mathematical analysis of the effects of changes in system's operating parameters on product/ service performance, quality, and cost. 3 lecture/problems. Prerequisite: MAT 214.

IE 327/327L Elements of Industrial Engineering Systems/Laboratory (3/1)

Concepts and principles of system engineering theory. Introduction to the theory and methodology of engineering systems. Development of analytic techniques to establish needs, objectives, priorities and utilities, and the evaluation of system effectiveness. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: IE 311.

IE 392 Principles of Productivity Engineering (3)

Productivity definitions, concepts, and trends, use of various industrial engineering techniques in productivity improvement, relationship between productivity and profit, phases of a productivity improvement project, case studies. Plant visits and guest speakers. 3 lecture/problems. Prerequisite: upper division standing.

IE 403 Engineering Cost Estimating (3)

Concepts and techniques of forecasting and estimating costs of engineering, manufacturing and service operations, products, equipment, projects, and systems. Preliminary and detailed procedures. Qualitative, quantitative and computer methods. 3 lecture/problems. Prerequisite: Junior standing in engineering.

IE 405 Engineering Economy (3)

Economic Decision making for engineering projects and capital expenditure proposals. Concept of time value of money, cash flow, and capital rationing. Basic comparative models for evaluating alternatives. Sensitivity and probability analysis; depreciation and tax consequences; replacement studies; consideration of intangibles. 3 lecture/problems. Prerequisite: Junior standing in an engineering major

IE 416 Operations Research I (4)

Applications of linear programming and non-linear programming, queuing theory, and other analysis techniques to problems encountered in industry and business. 4 lecture/problems. Prerequisites: IE 311.

IE 417 Operations Research II (4)

Development and application of planning and inventory models, networks and graph techniques, Markov analysis, waiting lines, simulation, and sequencing and scheduling algorithms to problems encountered in industry and business. 4 lecture/problems. Prerequisite: IME 312.

IE 419 Reliability Concepts and Techniques (3)

Reliability concepts and techniques as used in various types of industrial organizations. Analysis of the influence of reliability on such factors as complexity, state of the art, and environment. Component reliability related to systems requirements. 3 lecture/problems. Prerequisite: IME 312.

IE 426 Applied Decision Theory (3)

Introduction to decision theory and its applications. Modern utility theory and its application to decision making under risk and uncertainty. Applications of Bayesian decision theory. Emphasis on applications covering a wide range of both profit and nonprofit oriented institutions. 3 lecture/problems. Prerequisite: IME 312 or equivalent.

IE 429/429L Industrial Systems Simulation (3/1)

Systems analysis, design, and measurement. Data gathering and analytical tools used in formulating and optimizing work systems. Theory of systems concepts based on logical synthesis and empirical analysis. Case studies and industrial simulations. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: IME 312.

IE 436/436L Operations Planning and Control/Laboratory (2/1)

Analysis and design of systems for planning, scheduling and controlling production, inventory and service operations/activities. Use of mathematical and computer models. Projects and open-ended problems. 2 lecture/problems, 1 three-hour laboratory. Prerequisites: IE 327, IE 416, IME 326.

IE 437 Industrial Engineering Systems (3)

Concepts of systems engineering methodology. Methods of technological forecasting and future study. The design and analysis of complex systems under conditions of risk uncertainty and changing environment. 3 lecture/problems. Prerequisite: IE 327.

IE 490/490L Luminaries Design and Manufacture (3/1)

The design and manufacture of luminaries for various purposes and intents. This course will cover the fundamental strategies of efficient luminary design and manufacture. Through understanding the characteristics of different lamps, with the integration of enclosure material and geometry, the intent of luminary design will be evaluated on the merits of output, esthetics, and economics. The manufacturing of luminaries will uncover the technical issues in the production and economics of luminary design. 3 lecture/seminars, 1 three-hour laboratory.

IME 112 Industrial and Manufacturing Engineering Fundamentals (3)

Introduction to industrial and manufacturing engineering concepts, functions, and techniques. Solution of elementary industrial and manufacturing engineering problems. 3 lecture/problems.

IME 113/113L Industrial and Manufacturing Engineering Computations/Laboratory (1/1)

Fundamentals of digital computer methods, logic diagramming, programming in a high-level language. Computer solutions of elementary industrial and manufacturing engineering problems. 1 lecture/problem, 1 three-hour laboratory.

IME 134/134L Molding and Casting/Laboratory (1/1)

Shaping of metals while in the liquid state, common molding and casting techniques for both ferrous and non-ferrous materials and alloys. 1 lecture/problem, 1 three-hour laboratory.

IME 224/224L Work Analysis and Design/Laboratory (3/1)

Theory and application of work analysis as related to process design, facilities, workplace layout, tools and equipment, and services. Analytical techniques of measurement of work content including stopwatch time study, standard data, predetermined time systems, and work sampling. 3 lecture/problems, 1 three-hour laboratory.

IME 228/228L Electronic Process Design/Laboratory (1/1)

Design of manufacturing processes with particular emphasis on processes used in the electronics industry. Evaluation of alternative methods of processing depending upon delivery, volume, and quality specifications. Types of processes included are finishing, plating, printed circuit board production, component preparation and installation, chassis construction, electroforming, and packaging. 1 lecture/problem, 1 three-hour laboratory. Prerequisite: basic electronic and drafting course or consent of instructor.

IME 239 Industrial Costs and Controls (3)

Engineering approach to cost recording, budgetary procedures and controls. Estimating production costs. Engineering problems. Current techniques in automating the cost recording and cost control functions. 3 lecture/problems.

IME 280 Processes and Measurement (4)

Commonly used manufacturing and service processes and systems, units of measurement, and measurement techniques. Introduction to process capability and the continuous improvement process. Prerequisite: STA 120 or STA 309 or equivalent.

IME 299/299A/299L Special Topics for Lower Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Permission of instructor. Instruction is by lecture, laboratory, or a combination of both.

IME 301 Variability and the Statistical Approach to Engineering Design (3)

The study of variability in real-world engineering problems. Graphical methods of data analysis. Importance of the statistical approval to engineering design. The role of statistical tools in design and development. 3 lecture/problems. Prerequisite: MAT 116.

IME 312 Engineering Probability and Statistics (3)

Engineering applications of the concepts of probability, statistical distributions, statistical analysis, regression and correlation analysis, analysis of variance and covariance, design of experiments, and probabilistic and statistical models. 3 lecture/problems. Prerequisite: IME 301 or STA 309.

IME 326 Production Planning and Control (3)

Principles of production planning and control systems. Methods of forecasting, planning, scheduling, and controlling production operations and inventory activities. Quantitative models and computer systems. 3 lecture/problems. Prerequisites: IME 112, IME 312.

IME 331/331L Facilities Planning, Layout and Design/ Laboratory (3/1)

Planning and designing facilities, layouts, and material handling systems. Systems engineering approach; quantitative analysis methods; computerized techniques. Projects. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: MFE 201 or consent of instructor, IME 326. MFE 126/L recommended.

IME 400 Special Problems for Upper Division Students (1-2)

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

IME 415 Quality Control by Statistical Methods (4)

Systems of inspection, analysis and action taken to control the quality of manufacturing processes. Process control techniques, acceptance sampling methods, statistical analysis and other techniques used by management to control costs and improve quality. 4 lecture/problems. Prerequisite: IME 312.

IME 435/435L Design of Experiments (3/1)

Introduction to design and analysis of experiments. Applications in product and process design and development; process correction and quality improvement. Taguchi's loss-function approach to quality; signal-to-noise ratio analysis. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: IME 312.

IME 440 Design and Engineering of Automated Systems (3)

Principles of automated systems including automated material handling, assembly, inspection, and warehousing. Factory and office of the future. Fundamentals of computer-integrated manufacturing (CIM), robotics programming and applications, aspects of flexible manufacturing systems, and group technology, economics of automated factory. 3 lecture/problems. Prerequisite: senior standing.

IME 455/455L Principles of Robotics/Laboratory (2/1)

Components of robots, industrial robots, robot programming, economics of robotics, interfacing robots with process machines, parts feeders, conveyors and inspection devices, robot controllers, microprocessors, applications, case studies, plant visits. 2 lecture/problems, 1 three-hour laboratory. Prerequisite: senior standing.

IME 460 Undergraduate Seminar (2)

Preparation, oral presentation, and discussion by students of technical papers on recent engineering developments. 2 seminar/discussion. Prerequisite: senior standing.

IME 461, 462 Senior Project (2) (2)

Selection and completion of a project under faculty supervision. Projects typical of problems which graduates must solve in their fields of employment. Project results are presented in a formal report. Minimum 120 hours total time. Prerequisite: IME 460.

IME 499/499A/499L Special Topics for Upper Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: permission of instructor. Instruction is by lecture, laboratory, or a combination of both.

MFE 121L Engineering Design Graphics (2)

Functional graphic communication of engineering information including projection theory, sectional and auxiliary views, dimensioning, tolerancing and fastening devices, drawings for typical manufacturing methods, current drafting materials and practices. 2 three-hour laboratories.

MFE 122L Advanced Engineering Design Graphics (2)

Continuation of Engineering Design Graphics. Emphasis placed upon freehand sketching, working drawings, and descriptive geometry. Geometrical dimensioning according to ANSI 14.5. 2 three-hour laboratories. Prerequisite: MFE 121L or equivalent.

MFE 125L Descriptive Geometry (2)

Study of spatial geometric relationships between lines and planes. Graphical solution of common problems encountered in descriptive engineering expressions. 2 three-hour laboratories. Prerequisite: MFE 121L or equivalent.

MFE 126/126L Engineering Graphics I/Laboratory (2/1)

Engineering graphics for product design, manufacturing and construction. Emphasis on graphic communication used for processing parts and layouts. Orthographic projection, pictorial views, section and auxiliary views, dimensioning for production processing, and the four fundamental views of descriptive geometry. Use of instruments and CAD for engineering drawings. 2 lecture/problems, 1 three-hour laboratory.

MFE 201/201L Manufacturing Systems Processes/Laboratory (3/1)

Study of basic manufacturing processes with emphasis on terminology, technology, process principles and capabilities, material selection and comparative advantages and disadvantages. Processes discussed include material removal, joining, assembly and casting. Other topics include NC, measurement and gaging, and statistical methods. 3 lecture/problems. 1 three-hour laboratory.

MFE 210L Computer-Aided Drafting (2)

Application of the digital computer and plotter to engineering design and graphics. 2 three-hour laboratories. Prerequisite: MFE 121L or equivalent.

MFE 221/221L Manufacturing Processes I-Material Removal (2/1)

An introduction to science of metal removal and the physics of metal cutting as related to cutting tool geometry, material being cut and machine tool being used. Consideration of machine speeds, feeds, tolerances and surface finish determinates as related to both manually and numerically controlled machines, dynamics of metal cutting, tool life analysis, economics of machining, the concept of group technology in cellular and flexible modes. 2 lecture/problems, 1 three-hour laboratory.

MFE 222/222L Manufacturing Processes-Tool Selection (1/1)

Machine tools referenced to the study of cutting tool geometry, tool materials, cutting forces, feed, speed, surface finish, horsepower requirements, capacity, capability, efficiency, coolants, vibration, and machine tool evaluation. Computer applications. 1 lecture/problem, 1 three-hour laboratory. Prerequisite: MFE 221 or equivalent.

MFE 226/226L Engineering Graphics II/Laboratory (2/1)

Engineering graphics for manufacturing. Emphasis on preparation and use of detail drawings and assembly drawings and application of geometric and positional tolerancing (ANSI Y14.5). Interpretation of engineering drawings, representation of threads and fasteners, and assembly drawings using CAD. 2 lecture/problems, 1 three-hour laboratory. Prerequisite: MFE 126/126L or equivalent.

MFE 230/230L Manufacturing Processes II-Forming, Casting and Joining (2/1)

Theory and practice related to processes dealing with the deformation, consolidation and casting of engineering materials. Modern manufacturing methods are explored with emphasis placed on the application of engineering principles to the production of marketable products. Topics include: molding, casting, powder metallurgy, hot and cold working, welding and heat treating manufacturing processes and introductory exposure to manufacturing systems. 2 lecture/problems, 1 three-hour laboratory. Prerequisite: Consent of the instructor.

MFE 246L Graphics for Electronics (2)

Principles and techniques for design and drafting of printed circuit and integrated circuit electronic packaging systems. Design considerations, problems and practices are evaluated in the development and adaptation of electronic circuits and artwork for electronic and electrical printed circuit production processes. 2 three-hour laboratories. Prerequisite: Basic electronics and drafting courses.

MFE 310/310L Advanced Computer-Aided Drafting/Laboratory (2/1)

Advanced commands and the development of skills in 3-D visualization, integration of word processing and spreadsheets in drawing preparation; programming language for artificial intelligence; wireframe and solid modeling. 2 lecture/problems, 1 three-hour laboratory. Prerequisite: MFE 121, MFE 126/L or equivalent.

MFE 320/320L Measurement and Methods/Laboratory (3/1)

Commonly used units of measurement, measurement devices and measurement techniques found in industrial and environmental systems including dimensional measurement, force, electricity, time and work, noise, light, temperature, humidity, atmospheric constituents and radiation. Emphasis on metrology, work measurement and methods improvement. Introduction to process capability, measurement assurance and the continuous improvement process. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: Consent of the instructor.

MFE 323/323L Geometric Dimensioning and Tolerancing (2/1)

Basics of dimensioning and tolerancing, tolerances of form and position. Government and industry requirements. 2 lecture/problems, 1 three-hour laboratory. Prerequisite: MFE 121L or MFE 126/126L or equivalent.

MFE 326/326L Production Engineering/Laboratory (3/1)

The utilization of engineering concepts in the planning and design of processes and products. Selection of appropriate manufacturing processes and systems; sequences of operations, equipment and facilities; methods and tooling to assure optimum producibility. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: MFE 221/L and MFE 230/L.

MFE 350/350L Principles of Numerical Control (2/1)

Principles and applications of numerical control in manufacturing, manual and computer-assisted programming, CNC systems including microprocessor applications to production processes, advanced NC systems for full contouring, macro- and variable programming, programmable controllers for CNC and DNC applications in industry. 2 lecture/problems, 1 three-hour laboratory. Prerequisite: MFE 221 or equivalent.

MFE 373/373L, 374/374L Tool and Die Engineering, I, II (2/1) (2/1)

Introduction to tool and die fundamentals. Function, components and appropriate manufacturing techniques are stressed. Die life, maintenance, storage and safety are included. 2 lecture/problems, 1 three-hour laboratory. Prerequisites: MFE 221/L, MFE 230/L.

MFE 375/375L Computer-Aided Design/Computer-Aided Manufacturing/Laboratory (3/1)

Integration of computer-aided design principles, part design specifications and producibility concepts in computer-aided manufacturing applications. Emphasis on machine tools for flexible automation, CNC machining data generation, CAD/CAM interface and communication of automated systems. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: MFE 350/L and MFE 126/L or equivalent.

MFE 380/380L Manufacturing Metrology (1/1)

The science of engineering measurement as used in inspection and quality control. Emphasis is placed on the general use of scientific measuring devices and how these devices can be used to secure optimal conditions of manufacture. 1 lecture/problem, 1 three-hour laboratory.

MFE 406 Safety Engineering (3)

Principles of safety engineering applied to manufacturing systems. Control of noise, heat, electrical hazards, vibration, radiation, lighting, and air contaminants in the workplace. Accident prevention. Material handling safety,

machine guards and personal protection equipment. 3 lecture/problems.

MFE 410/410L Computer-Aided Design (1/1)

Introduction to interactive computer graphics systems with emphasis on its application in engineering design. Course taught in an industrial environment. 1 lecture/problem, 1-three hour laboratory. Prerequisites: A course in computer programming, MFE 126/L or equivalent.

MFE 411/411L Manufacturing Processes-Finishing (1/1)

A comprehensive overview of the possibilities and limitations of finishing processes for both metallic and non-metallic materials. Consideration of cleaning methods, surface conditioning, and coating processes as related to obtaining high-quality products at reduced manufacturing costs. 1 lecture/problem, 1 three-hour laboratory. Prerequisite: MFE 201/L or equivalent.

MFE 421 Manufacturing Operations Analysis (3)

Analysis of manufacturing operations with emphasis on system optimization, problem solving, feasible systems alternatives and cost considerations. 3 lecture/problems. Prerequisites: IME 312.

MFE 430 Manufacturing Cost Estimation (3)

A study of cost estimation of modern manufacturing based on processing analysis. The role, function and use of various types of estimates are discussed. 3 lecture/problems. Prerequisite: Senior standing.

MFE 438/438L Plastics Engineering I/Laboratory (2/1)

An investigation of non-metallic plastic materials, their sources, and polymer combination. Overview of organic chemistry as it relates to plastics polymer chemistry. Plastic formulas, mixing characteristics, flow characteristics, stability and additives. Basic plastic polymers (both thermosetting and thermoplastic resins). 2 lecture/problems, 1 three-hour laboratory.

MFE 439/439L Plastics Engineering II/Laboratory (2/1)

A study of non-metallic plastic processing techniques. Coatings, laminations, machining, compression, transfer, injection, extrusion, vacuum, blow molding and casting processes. An analysis of the major production techniques for thermoset and thermoplastic resin. 2 lecture/problems, 1-three hour laboratory. Prerequisite: MFE 438.

MFE 450/450L Introduction to Computer Integrated Manufacturing/Laboratory (3/1)

Principles of high volume manufacturing systems, automated material handling and storage devices, control systems in manufacturing, data communication, part recognition. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: ECE 333 or ETE 210 or equivalent.

MFE 465 Metal Working Theory and Applications (3)

Three-dimensional stress and strain analysis, yield criteria for ductile metals. Stress-strain relations. Phenomenological nature of engineering metals. Plane strain plastic deformation. Plastic strain with axial symmetry and pseudo plane stress. Extremum principles for plastic material. 3 lecture/problems. Prerequisites: MFE 221, MFE 230, ME 218.

MFE 476/476L Advanced Computer-Aided Manufacturing Systems/Laboratory (3/1)

Principles of group technology, cellular manufacturing, computer aided process planning, flexible manufacturing systems and computer networks in manufacturing. Applications of artificial intelligence and expert systems in manufacturing. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: MFE 450/450L.

MFE 484 Producibility Engineering (3)

Engineering methodologies and design practices which have proven in industry to improve product producibility, reliability, and quality are presented. Concepts include concurrent engineering, just-in-time manufacturing and cellular arrangements for flexible manufacturing.

MFE 499/499A/499L Special Topics for Upper Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: permission of instructor. Instruction is by lecture, laboratory, or a combination of both.

MECHANICAL ENGINEERING

George F. Engelke, *Chair*
Leonard Berkowitz
Peter A. Dashner
Edward M. Gates
James D. Goodin
Gary W. Koonce
Carl E. Rathmann
Charles L. Ritz
Michael T. Shelton
John R. Biddle
Uei-Jiun Fan
Vladimir Glozman
William C. Hauser
David L. Miller
Hassan M. Rejali
Kenneth J. Schneider
William B. Stine

Mechanical engineering has traditionally been one of the most general branches of engineering. A mechanical engineer requires a broad knowledge in many fields: mechanics, thermal science, design, machinery and instrumentation, energy, control system theory and more. The breadth and flexibility of a mechanical engineer's education provides a wide choice of careers and allows movement into a variety of engineering areas to better meet the challenges of a changing world. The accredited mechanical engineering curriculum permits students to explore different fields, specializing in one or more of them as they find their true interests. Option programs in petroleum engineering, energy systems engineering and mechanical engineering are available under the degree major.

During the junior and senior years students may choose "a technical elective package with faculty approval. The department offers technical electives in the areas of advanced machine design, energy systems engineering, solar engineering, petroleum engineering, thermo-fluids engineering and advanced mechanics. Principles developed in the classroom are applied to the operation and testing of heat transfer equipment, fluid handling equipment, energy, energy systems, petroleum engineering equipment, environmental control systems, internal and external combustion engines and engineering materials in the various laboratories.

Students desiring to major in Mechanical Engineering should have a particularly high aptitude for science and mathematics, and incoming freshmen should have taken substantial college preparatory courses in these disciplines in high school. Incoming transfer students should have completed at least one year of college calculus and one year of college physics (with laboratory) prior to beginning the program at Cal Poly. The community college student planning to transfer into this department should consult a school counselor or this department to determine which courses meet the program requirements.

Mechanical engineers work in industry, business, government, universities, and in the other professions of law and medicine. They are involved in research, development, design, testing, production, operation, maintenance, marketing, sales, administration, management, and education. Graduates of the program are prepared to do productive work in their first jobs as well as to grow with their profession throughout their engineering career. The curriculum is designed to prepare a student for direct entry into the engineering profession and for graduate school.

Mechanical engineering students are encouraged to become active in the student chapters of the American Society of Mechanical Engineers, the Society of Automotive Engineers, The Society of Petroleum Engineers, the American Society of Heating, Refrigeration and Air Conditioning Engineers, and The Association of Energy Engineers. Qualified students are invited to join the student chapter of Pi Tau Sigma, the mechanical engineering honor society.

CORE COURSES FOR MAJOR*

(Required of all students)

Mechanical Engineering Orientation	ME	100L	(1)
Engr Digital Computations	ME	132/142L	(3)
Vector Statics	ME	214	(3)
Vector Dynamics	ME	215	(4)
Strength of Materials	ME	218	(3)
Strength of Materials	ME	219	(3)
Strength of Materials Laboratory	ME	220L	(1)
Engineering Materials	ME	225	(4)
Intro to Mechanical Design	ME	233/L	(4)
Thermodynamics	ME	301	(4)
Thermodynamics	ME	302	(4)
Fluid Mechanics	ME	311	(3)
Fluid Mechanics	ME	312	(3)
Fluid Mechanics Lab	ME	313L	(1)
Stress Analysis	ME	319	(3)
Materials Design Lab	ME	350L	(1)
Mechanical Vibrations	ME	413	(4)
Heat Transfer	ME	415	(4)
Adv. Engg. Measurements	ME	435/445L	(4)
Senior Project	ME	461	(2)
Senior Project	ME	462	(2)
Undergraduate Seminar	ME	463	(2)
Analytical Geometry & Calculus	MAT	115	(4)
Analytical Geometry & Calculus	MAT	116	(4)
Calc of Several Variables	MAT	214	(3)
Calc of Several Variables	MAT	215	(3)
Differential Eqns	MAT	216	(4)
General Physics	PHY	131/151L	(4)
General Physics	PHY	132/152L	(4)
General Physics	PHY	133/153L	(4)

OPTION COURSES FOR MAJOR*

(Required for Specific Option)

Energy Systems Engineering Option

Energy Management	ME	306	(4)
Alternative Energy Systems	ME	307	(4)
Petroleum Des. Engr.	ME	427/447L	(4)

Electives to be chosen from the following list (12 units total)

Solar Thermal Engineering	ME	407	(4)
Nuclear Engineering	ME	408	(4)
Kinetic Theory/Statistical Thermodynamics	ME	409	(4)
Heat Power	ME	411/431L	(4)
Internal Combustion Engines	ME	412/422L	(4)
Building Energy Calculations	ME	417/437L	(4)
Air Conditioning	ME	418/428L	(4)

Mechanical Engineering Option

Vector Statics Lab	ME	214L	(1)
Intermediate Dynamics	ME	316	(3)
Machine Design	ME	325/335L	(4)

Technical Electives (At least 12 units must be in ME Department) . . . . . (16)

Petroleum Engineering Option

Principles of Geology Lab	GSC	141L	(1)
Historical Geology Lab	GSC	151L	(1)
Petroleum Geology	GSC	351/L	(4)
Intro to Petroleum Engineering	ME	101L	(1)
Vector Statics Lab	ME	214L	(1)
Petroleum Design Engineering	ME	427/447L	(4)
Petroleum Drilling Engineering	ME	401	(4)
Petroleum Reservoir Engineering	ME	402	(4)
Petroleum Production Engineering	ME	403	(4)

SUPPORT AND ELECTIVE COURSES

(Required of all Students)

General Chemistry	CHM	112	(3)
Elements of Elec Engr	ECE	231/251L	(4)

* A 2.0 cumulative GPA is required in core courses including option courses for the major in order to receive a degree in the major.

Manufacturing Systems Processes	MFE	201/211L	(4)
Engineering Graphics I	MFE	126/L	(3)
Engineering Graphics II	MFE	226/L	(3)

courses including option courses for the major in order to receive a degree in this major.

GENERAL EDUCATION COURSES

An alternate pattern from that listed here for partial fulfillment of Areas 1, 3, and 4 available for students in this major is the Interdisciplinary General Education (IGE) Program. Please see the description of IGE elsewhere in this catalog.

Area 1:

Freshman English I	ENG	104	(4)
Mech Engr Communications	ME	231	(4)
Advocacy and Argument	COM	204	(4)

Area 2:

Analytical Geometry & Calculus	MAT	114	(4)
General Chemistry	CHM	111/151L,152L	(5)
Life Science	BIO	110	(3)
Engg. Num. Computations	ME	330	(4)

Area 3:

3A Elective+			(4)
3B Elective+			(4)
3C Elective+			(4)
3D Principles of Economics	EC 201 or ECE 202		(4)
*Political Sociology	SOC/PLS	390	(4)
3G Elective+			(4)

Area 4:

Intro to Amer Government	PLS	201	(4)
United States History	HST	202	(4)

Area 5:

Elec Inst & Control	ECE	333/383L	(4)
Capital Allocation Theory	EGR	403	(4)

* Course counted in multiple categories. +One course of those indicated must satisfy the American Cultural Perspectives requirement. Underlined courses satisfy both major and G.E. requirements.

Course Descriptions

All students in engineering and engineering technology curricula must satisfy ENG 104 prior to enrolling in any 300-level or higher course in the College of Engineering. Lecture and laboratory courses listed together are to be taken concurrently.

ME 100L Mechanical Engineering Orientation (1)

Introduction to the resources and facilities of the mechanical engineering department. An overview of career opportunities and introspection about mechanical engineering. Various forms of engineering communication including report writing, graphical presentations and problem-solving format. Becoming conversant with unit systems and dimensional analysis. 1 three-hour laboratory.

ME 101L Introduction to Petroleum Engineering (1)

Lecture-discussion, movies, speakers and field trips are utilized to illustrate terminology, practices and career opportunities in the petroleum and energy areas for the mechanical engineer. 1 three-hour laboratory.

ME 132/142L Engineering Digital Computations/Laboratory (2/1)

Problems involving basic computational methods including elementary concepts of digital computer programming. Proficiency will be gained in writing computer programs using FORTRAN. Assignments include the use of the computer facilities. 2 lecture/problems, 1 three-hour laboratory. Corequisite: MAT 114.

ME 214 Vector Statics (3)

Two and three dimensional equilibrium of frames, machine and trusses employing vector algebra. Principles of friction, centroids and center of gravity, moments of inertia for areas and masses. 3 lecture/problems. Prerequisites: C or better in PHY 131. Corequisite: MAT 214.

ME 214L Vector Statics Laboratory (1)

Spatial visualization, free-body diagramming, vector manipulation, force transmission and distribution, force balances, force-moment equivalences, practice in recognizing and developing problem-solving techniques. 1 three-hour laboratory. Corequisite: ME 214.

ME 215 Vector Dynamics (4)

Vector mathematics of absolute and relative motion of particles and the planar motion of rigid bodies in an inertial reference frame. Newton's laws of motion, work-energy, impulse-momentum. 4 lecture/problems. Prerequisite: C– or better in ME 214. Prerequisite: MAT 214.

ME 218 Strength of Materials (3)

Plane stress and strain. Principal stresses and strains, Mohr's Circle. Properties of materials, stress strain diagrams. Generalized Hooke's Law for isotropic materials. Design loads, working stresses, and factor of safety. Statically indeterminant axially loaded members. Torsional shearing stresses and displacements. Combined axial and torsional loads. Flexural and transverse shear stresses. Shear and moment diagrams. Beams of two materials. Thin-walled pressure vessels. 3 lecture/problems. Prerequisite: C– or better in ME 214.

ME 219 Strength of Materials (3)

Deflection and slope of beams by double integration, singularity functions, superposition and energy methods. Statically indeterminate beams. Column analysis with centric and eccentric loads. Combined axial, torsional, and flexural stresses. Theories of failure (ductile and brittle). Thick-walled pressure vessels. 3 lecture/problems. Prerequisite: C– or better in ME 218.

ME 220L Strength of Materials Laboratory (1)

Standard physical tests of engineering materials including torsion, tension, compression and bending. Experimental stress analysis using strain gages. 1 three-hour laboratory. Corequisite: ME 219. Prerequisites: C– or better in ME 231. A score of 6 or better on GWT.

ME 225 Engineering Materials (4)

Relevance of materials science concepts in engineering. Metallurgy and strengthening methods for ferrous and non-ferrous metals. Engineering properties and applications of metals, plastics, ceramics, elastomers, and composites. Principles of corrosion protection. 4 lecture/problems. Prerequisites: CHM 112, C– or better in ME 218.

ME 231 Mechanical Engineering Communications (4)

The mechanics of effective engineering communications. Composition and style of various types of written and oral presentations of technical information. Critical analysis of specifications related to the design, test and performance of components and systems typically found in the field of mechanical engineering. 4 lecture/problems. Prerequisite: ENG 103 or 104, C– or better in ME 100. Corequisite: ME 218.

ME 233/233L Introduction to Mechanical Design (3/1)

Introduction to machine and product design techniques and the design and selection of power transmission elements such as couplings; U-joints; roller and silent chains; V, flat and gear belts; gears and gear transmissions; friction drives; electric motors. Introduction to shaft design, bearings and attachments. The execution of layouts and engineering specifications for manufacture. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: MFE 126/L, C– or better in ME 214.

ME 299/299A/299L Special Topics for Lower Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Permission of instructor. Instruction is by lecture, laboratory, or a combination of both.

ME 301 Thermodynamics (4)

Thermodynamic properties and processes; equations of state; tables and charts of thermodynamic properties; work and heat, the first law of thermodynamics and first law properties; the second law of thermodynamics and entropy; power cycles, 4 lecture/problems. Prerequisites: PHY 132, C– or better in ME 214.

ME 302 Thermodynamics (4)

Rankine cycle and its variations; refrigeration cycles; advanced Brayton cycle and Otto and Diesel cycles; mixtures of ideal gases; Maxwell relations; thermodynamic properties for real gases. 4 lecture/problems. Prerequisite: C– or better in ME 301. Corequisite: MAT 215

ME 306 Energy Management (4)

Energy system modeling; forecasting techniques; analysis of energy requirements; energy audits; net energy analysis; conservation strategies; energy, environment and economics interface; role of energy management and case studies. 4 lecture/problems. Prerequisite: C– or better in ME 301 or equivalent.

ME 307 Alternative Energy Systems (4)

Analysis and synthesis of energy systems; fossil fuel systems; viable alternative energy sources, solar, geothermal, wind, biomass, hydro and ocean resources; conversion, storage, and distribution. Environmental impact and economics of alternative systems. Synthesis of energy system components. 4 lecture/problems. Prerequisites: C– or better in ME 301 or equivalent.

ME 311 Fluid Mechanics (3)

Analysis and problems dealing with properties and behavior of fluids at rest and in motion. Fundamental concepts; fluid statics; transport theorem; flow of incompressible frictionless fluid; laminar and turbulent flow of real fluids in closed conduits; impulse and momentum applied to fluids; fluid measurement. 3 lecture/problems. Prerequisites: PHY 132 and MAT 214. C– or better ME 215.

ME 312 Fluid Mechanics (3)

Similarity and dimensional analysis; steady closed conduit flow in pipe networks; flow of real compressible fluids; additional topics selected from boundary layers, turbulence, drag and dynamic machinery. 3 lecture/problems, Prerequisite: C– or better in ME 301 and 311.

ME 313L Fluid Mechanics Laboratory (1)

Measurement of viscosity, centrifugal pump performance, pressure drop in a pipe, air velocity distribution from a fan discharge. Calibration and use of laboratory equipment; acquisition, processing, and analysis of data by manual and automated methods; report writing. 1 three-hour laboratory. Prerequisites: A score of 6 or better on the GWT, C– or better in ME 231 Corequisite: ME 312.

ME 316 Intermediate Dynamics (3)

Three dimensional particle dynamics and rigid body kinematics, motion relative to rotating reference frames, moments and products of inertia, momentum and energy principles, gyroscopic motion. 3 lecture/problems. Prerequisite: C– or better in ME 215.

ME 319 Stress Analysis (3)

Stress concentration. Repeated loading involving fatigue and endurance strength. Shaft design. Introduction to energy methods. Design of screws, fasteners, and connections. Shrink fit. Special topics. 3 lecture/problems. Prerequisites: C– or better in ME 219 and ME 220.

ME 320 Creativity (3)

A class to improve the student's creative ability and output. Stiflers are studied and ways to overcome them are applied. Known creative techniques and exercises are performed both individually and in groups. Methods of protecting and selling ideas or inventions are presented. 3 lecture/problems. Prerequisite: Junior Standing.

ME 325/335L Machine Design/Laboratory (3/1)

Design and application of machine components such as brakes, clutches, gears, mechanisms, bearings, ways, sleeves, and bushings. Lubrication of machine elements, gaskets, seals, "o" rings, and fasteners. Design techniques and the design of a simple machine. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: MFE 201/211L, 226/L. C– or better in ME 215, 233/L and 319.

ME 326/336L Machine Design/Laboratory (3/1)

The emphasis of this course will be placed on the actual process of design. Lectures and laboratories will be devoted to the design of complete mechanisms and machines based on solid modeling and finite element analysis. The projects are so chosen as to demand the application of knowledge learned in other courses and act as a synthesizing agent. Real industrial problems are used as projects. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: C– or better in ME 325/335L.

ME 330 Engineering Numerical Computations (4)

Numerical methods applied to the solution of problems in engineering. Roots of equations, matrix methods, curve fitting, numerical integration and differentiation, numerical solution of differential equations. 4 lecture/problems. Prerequisites: MAT 216, and C– or better in ME 132.

ME 340 Synthesis of Mechanical Engineering Problems (3)

Analysis and synthesis of steady-state and transient engineering problems associated with mechanical engineering. Emphasis is placed upon formulating the differential or fundamental equations from basic assumptions and applying various methods of solution. 3 lecture/ problems. Prerequisite: MAT 216, C– or better in ME 215, 301, 311.

ME 350L Materials Science and Selection Laboratory (1)

Laboratory tests of cold working, annealing, heat treatment, galvanic corrosion, and mechanical properties of polymers. Material selection for prescribed applications. 1 three-hour laboratory. Prerequisite: C-or better in ME 225 and ME 231, or equivalent.

ME 400 Special Problems for Upper Division Students (1-2)

Individual or group investigation, research, studies or surveys of selected problems. The student(s) must submit a proposal of the work to be done to the ME Curriculum Committee and obtain the committee's approval before beginning the proposed effort. Total credit limited to 4 units, with a maximum of 2 units per quarter.

ME 401 Petroleum Drilling Engineering (4)

Drilling programs and concepts; optimizing penetration rates; rheology of drilling muds and lifting capacity; system pressure losses and optimization of hydraulics; well completions and casing design. 4 lecture/problems. Prerequisites: C– or better in ME 219 and ME 311 or equivalent.

ME 402 Petroleum Reservoir Engineering (4)

Reservoir performance methods associated with decline curve analysis, material balance, steady state and unsteady state flow, diffusivity equation and pseudo-steady state fluid flow. Radial reservoirs: Ei solution, constant terminal pressure solution. Pressure distributions in multiple wells, superposition, and well testing. 4 lecture/problems. Prerequisite: C– or better in ME 311.

ME 403 Petroleum Production Engineering (4)

Oil-gas separation systems and facilities, oil field water systems, artificial lift, water quality analysis, water flood and injector performance, well stimulation, cementing and well economics. 4 lecture/problems. Prerequisites: C– or better in ME 219 and ME 311.

ME 404 Piping Stress and Design (4)

Pressure piping codes, petroleum refinery piping and support design; pipe stress analysis under thermal friction, wind and seismic loads; equipment loads of pumps, turbines, compressors, heat exchangers; flexible connectors; vibration of reciprocating machinery. 4 lecture/ problems. Prerequisites: C– or better in ME 319.

ME 405 Acoustics and Noise Control (4)

Fundamental acoustic parameters (dB, dBA, PSIL, octave band). Physiological response to noise. Noise standards. Sound pressure-power relation. Noise measurement, with individual experience using a Precision Integrating Noise Meter. Noise suppression by absorption, isolation and resonators. Case studies in noise control and reduction. 4 lecture/problems. Prerequisite: C– or better in ME 301, or ME 311, or consent of instructor.

ME 406 Finite Element Analysis (4)

Stiffness and influence coefficients. Shape functions. Element stiffness. Coordinate transformations. Assemble stiffness matrix. Solution to give deflections and forces, or analogous parameters for heat transfer and fluid flows. Apply a widely-used finite element computer program (NASTRAN) to structure design, heat transfer and/or fluid flow. 4 lecture/problems. Prerequisite: C– or better in ME 330 and ME 319, or consent of instructor.

ME 407/417L Solar Thermal Engineering (3/1)

Solar radiation distribution and measurement; methods of solar energy collection; thermal analysis of flat plate solar collectors; experimental testing and efficiency determination; solar energy storage; solar economics; transient and long-term system performance; computer modeling for solar space and water heating applications. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: C– or better in ME 415, or equivalent.

ME 408 Nuclear Engineering (4)

Nuclear power plant design, operation and safety. Reactor vessel internal and core components. Nuclear physics. Neutron reactions, fission and moderation. Reactor physics and reactor kinetics. 4 lecture/problems. Prerequisites: MAT 216, PHY 133, C– or better in ME 301, and senior standing.

ME 409 Kinetic Theory/Statistical Thermodynamics (4)

Review of classical thermodynamics; kinetic theory of an ideal gas; distribution of molecular velocities; transport phenomena; quantum mechanics; Bose-Einstein quantum statistics; Maxwell-Boltzmann statistics; partition functions; advanced kinetic theory. 4 lecture/problems. Prerequisite: C– or better in ME 302 and ME 312, or equivalents.

ME 411/431L Heat Power/Laboratory (3/1)

Application of the principles of thermodynamics to actual power plant cycles. Rankine cycle and its variations; boiler and steam turbine heat balance and efficiency; steam plant auxiliaries, plant heat balance and efficiency; gas turbine and combined cycles. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: C– or better in ME 302 and ME 312.

ME 412/422L Internal Combustion Engines/Laboratory (3/1)

The development of analytical and experimental techniques to estimate the performance of internal combustion engines. Discussion includes ideal and actual cycles, combustion, carburetion, fuel injection, ignition, supercharging, cooling, and fuels as applied to spark ignition and compression ignition engines. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: C– or better in ME 302, or consent of instructor.

ME 413 Mechanical Vibrations (4)

Free and forced vibration with and without damping. Periodic and aperiodic excitation. Rotating unbalance, vibration isolation, vibration measuring instruments, vibration of several degrees of freedom. 4 lecture/problems. Prerequisites: MAT 216, C– or better in ME 215, and ME 330 or equivalent.

ME 415 Heat Transfer (4)

Basic principles of conduction, convection, and radiation heat transfer. One-dimensional and multi-dimensional conduction, steady and unsteady state. Theoretical and empirical relations for free and forced convection in external surface flows and in tube and duct flows. Heat exchangers. Basic laws of radiation heat transfer, radiation properties of surfaces and radiant energy exchange among simple surfaces. 4 lecture/problems. Prerequisites: MAT 216, C– or better in ME 301 and ME 311.

ME 417/437L Building Energy Calculations/Laboratory (3/1)

Psychrometrics; thermal environmental requirements for human habitation; calculation of building heating and cooling loads; predicting building energy use. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: C– or better in ME 301 and 311.

ME 418/428L Air Conditioning/Laboratory (3/1)

Review of psychrometrics; room air distribution; building air distribution systems; principles of refrigeration; refrigeration equipment; combustion; heating equipment; air conditioning system types. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: C– or better in ME 301 and ME 311.

ME 421/421L Dynamics of Machinery (3/1)

Position, velocity and acceleration analysis of mechanical mechanisms by analytical, graphical and computer techniques. Determination of static and dynamic forces on machine components and linkages. Balancing of rotating masses. Critical speeds of shafts. Analysis of gyroscopic action with applications. 3 lecture/problems and 1 three-hour laboratory. Prerequisite: C– or better in ME 316.

ME 427/447L Petroleum Engineering Design/Laboratory (3/1)

Selection of heat exchangers, compressors, pumps, steam generators, and accessories to meet performance requirements encountered in petroleum industry. Design of a thermal-fluid mechanical system to meet a petroleum engineering requirement. Preliminary design and preparation of specifications for procurement of thermal-fluid-mechanical equipment to meet performance requirements. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: C– or better in ME 415.

ME 435/445L Advanced Engineering Measurements (3/1)

Analysis of the generalized measurement system with application of sensing, modifying and signal read-out equipment to problems of engineering measurements. Harmonic analysis; uncertainty and error analysis. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: ECE 333 and C– or better in ME 413 and ME 313L. A score of 6 or better on the GWT.

ME 438/448L Human Engineering in Design/Laboratory (2/1)

Design of products and/or systems based on the theory of human engineering principles, study of dimensional and strength characteristics of human anatomy, capabilities and limitations of senses, responses to sensory stimuli. The application of human engineering principles or human factors in the design and mock-up of projects. 2 lecture/problems, 1 three-hour laboratory. Prerequisite: Junior standing in engineering.

ME 439/449L Design of Machine Controls/Laboratory (3/1)

Design and comparisons of hydraulic and pneumatic power systems. Control logic using Boolean algebra and truth tables. Pneumatic control circuit theory and design. Electrical control circuit theory and design. The design and programming of control circuits using microprocessors and programmable

sequences. The design of control projects. Recent design developments. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: C– or better in ME 413.

ME 461, 462 Senior Project (2) (2)

Selection and completion of a project under faculty supervision. Projects typical of problems which graduates must solve in their fields of employment. Project results are presented in a formal report. Minimum 120 hours total time. Prerequisite: C– or better in ME 463.

ME 463 Undergraduate Seminar (2)

New developments, policies, practices, procedures and ethics in mechanical engineering. Each student is responsible for the preparation of a senior project proposal and the development and oral presentation of a topic in the field of mechanical engineering. 2 lecture seminar/discussions. Prerequisites: C– or better in ME 231 or equivalent, must have satisfied the GWT requirement.

ME 499/499A/499L Special Topics for Upper Division Students (1–4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: permission of instructor. Instruction is by lecture, laboratory, or a combination of both.