
COLLEGE OF
ENGINEERING
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COLLEGE OF ENGINEERING

www.csupomona.edu/engineering

Donald P. Coduto, Interim Dean
Cordelia Ontiveros, Associate Dean

Engineering is a dynamic profession that provides the expertise to meet the technical challenges facing the nation. Cal Poly Pomona's College of Engineering has a well-earned reputation of helping to meet these challenges by preparing engineers and engineering technologists who, upon graduation, are prepared to contribute to industry and are also ready for graduate studies. The emphasis on a strong theoretical background coordinated with early and significant laboratory experiences continues to make the college a leader in engineering education. In consultation with its many constituencies, the College of Engineering has adopted the following as its principal educational objectives:

- Preparation of graduates for immediate entry into the engineering profession, technically well-prepared in analysis and design, and understanding their professional responsibilities for contemporary and future human welfare
- Preparation of graduates as practicing engineers who communicate effectively, work collaboratively, learn independently and act ethically
- Adoption by graduates of life long learning, including formal advanced studies, as necessary for continued effectiveness in the profession

The College of Engineering provides study opportunities to undergraduate and graduate students in eleven disciplines, offering programs leading to Bachelor of Science degrees in:

Aerospace Engineering
Chemical Engineering
Civil Engineering
Computer Engineering
Electrical Engineering
Industrial Engineering
Manufacturing Engineering
Mechanical Engineering
Engineering Technology
Construction Engineering Technology
Electronics and Computer Engineering Technology

The programs each require 198 units for the Bachelor of Science degree.

In addition, the college offers individualized programs leading to the Master of Science degree in Electrical Engineering, Engineering Management, Mechanical Engineering, Civil Engineering, and Engineering.

All undergraduate engineering programs are accredited by the Engineering Accreditation Commission of ABET. The programs in Engineering Technology are accredited by the Technology Accreditation Commission of ABET. The address, phone number, and URL of ABET are:

ABET, Inc.
111 Market Place, Suite 1050
Baltimore, MD 21202
(410) 347-7700
www.abet.org

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 professional expectations, 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.

It is important to distinguish between Engineering and Engineering Technology. Engineering Technology is that part of the technological field that 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 a bachelor's degree in Engineering Technology include coursework in mathematics and basic sciences; technical sciences, specialties, and electives; and social sciences/humanities and communication.

As a result of Cal Poly Pomona's "learn by doing" environment, graduates of the college continue to be in great demand by industry in southern California, helping Cal Poly Pomona fulfill its mission of service to the people of California. Cal Poly Pomona's engineering curricula demand that students take computer programming and engineering orientation courses in the freshman 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 college's Industry Action Councils, composed of over 200 leaders in local industry. 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 Fundamentals of Engineering Examination (FE) before they graduate.

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. All students of the college obtain a copy of the college's policies and procedures from the website. The site is not meant as a substitute for the personal advising of students by faculty, but helps promote an understanding of the fundamental operating tenets on which engineering education at Cal Poly Pomona is based.

All students, faculty, and staff of the College of Engineering should know and understand both the academic policies of the college 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 that the faculty, students and the engineering profession as a

whole expect of themselves.

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 make a graduate of the Cal Poly Pomona's College of Engineering desirable.

Faculty 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 is 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 valuable academic advising, maintain the announced office hours, teach the stated content of each course, share their personal professional experiences and evaluate student performance fairly and consistently.

Additionally, 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 intensive 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 the 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 credos, 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 technological matters, 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 knows that professional diligence mirrors personal diligence. Accordingly, the faculty of the College of Engineering, while subscribing to the academic policies of the university, also feels dutybound to expect their students and themselves to answer to the set of high academic standards corresponding to those of the engineering culture.

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

Student Advocacy

The Dean's Office in the College of Engineering provides student advocacy services to students who are experiencing extraordinary personal challenges, have unusual situations requiring administrative intervention, or are facing serious dilemmas in their academic careers. Students should seek the help of this office only after discussing the situation with their faculty advisors. Student advocates are available to listen and talk with students, to provide feedback of value, to guide the student to other on-campus services available to them, and, in rare cases, to advocate on behalf of the student with faculty and administrators if appropriate. Student advocacy services are provided

- to assist students in honestly evaluating and facing their situations;
- to help students establish a realistic plan to achieve graduation, or consider new career directions; and
- to help students mature in accepting personal responsibility for their actions and inactions. Faculty advisors retain principal responsibility for academic advising; the college's student advocacy services supplement the faculty advising system.

CENTER FOR LIGHTING EDUCATION AND APPLIED RESEARCH (C.L.E.A.R.)

R. Frank Smith, Director

The Cal Poly Pomona Illumination Education Program prepares entry level professionals to apply the principles of lighting efficiency and effectiveness to the diverse field of Illumination Engineering and Design. An integral part of the program is maintaining an applied research and development interface between the lighting industry and the University faculty, students, and physical facilities. The goal of the Center for Lighting Education and Applied Research (C.L.E.A.R.) is to significantly enhance the quantity and quality of professional expertise in the field of lighting that would allow individuals to develop and demonstrate implementable lighting technology.

ENGINEERING INSTITUTE

Donald P. Coduto, Interim Director

The Engineering Institute works on new development for furthering innovations in the College of Engineering programs.

MEP Maximizing Engineering Potential

The MEP program at Cal Poly Pomona, established in 1983, is a retention and academic enhancement program for students in Engineering and Computer Science. The purpose of the program is to increase the number and diversity of students who graduate in these technical disciplines, including those from historically under-represented groups. This purpose is accomplished by implementing four specific support strategies:

- Building a collaborative learning community among students with similar career goals.
- Constructing the bridges necessary to establish a mentor-protege relationship between faculty and students.
- Expecting excellent performance.

- Maintaining effective linkages with the university community and the industrial community.

The Cal Poly Pomona MEP program is the largest in California and has a high retention rate. The program has specific service components designed to support students' successful pursuit of an academic program, their achievement of a timely graduation as well as assist them with their personal concerns. These service components include:

Admission and Matriculation	Academic Advising
Summer Program	Counseling
Orientation Courses	Student Organizations
Academic Excellence Workshops	Scholarships/Incentive Grants
Study Centers	Summer Jobs/Part-time Work
Building Community	Professional Development

MEP is supported by the College of Engineering, the California State University, the National Science Foundation (NSF), NASA, and by Industry through the MEP Industry Advisory Board, a group representing more than 20 major corporations.

Academic Excellence Workshops

Academic Excellence Workshops, administered through MEP, supplement 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.

COLLEGE OF ENGINEERING MINORS

Students in consultation with the coordinator of the minor are to develop a program of study to meet undergraduate minor requirements. A "Request for Award of Minor" form will be completed towards the completion of the minor course work and indicated on a student's permanent record (transcript) upon achieving at least a 2.0 for all minor work completed. This form is available in departments which offer minors. The form must be turned in to the Registrar's Office for proper processing. Minors cannot be awarded subsequent to the granting of a bachelor's degree. All minors, consist of 24 or more quarter units, 12 of which must be upper division units.

ENERGY ENGINEERING MINOR

John R. Biddle, Coordinator of the Minor, Mechanical Engineering
Energy Engineering Minor Committee Members:
John R. Biddle, Mechanical Engineering
Frank Janger, Civil Engineering
Lloyd Lee, Chemical Engineering
Hector Mireles, Physics

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:

Energy Management Engineering	ME	306	(4)
Energy and Society	PHY	301	(4)
Thermodynamics	ME	301	(4)
or Chemical Thermodynamics I	CHE	302	(4)
or Thermal Physics	PHY	333	(4)

The remainder of the 24 units required for the minor will be selected from the following list (ME students may not take more than one ME course from this list):

Environment Resource Management	CE	351/L	(3/1)
Solid Waste Management	CE	457	(3)
Pollution Abatement	CHE	432	(2)
Power System Electronics	ECE	468/L	(3/1)
Alternative Energy Systems	ME	307	(4)
Solar Thermal Engineering	ME	407/L	(3/1)
Nuclear Engineering	ME	408	(4)
Heat Power	ME	411/L	(3/1)
Internal Combustion Engines	ME	412/L	(3/1)
Building Energy Calculations	ME	417/L	(3/1)
Air Conditioning	ME	418/L	(3/1)
Thermal Systems Design	ME	427	(4)
Life Support Processes	RS	301	(4)
Currrent Applications in Regenerative Studies	RS	414/414L	(3/1)

ILLUMINATION ENGINEERING MINOR

R. Frank Smith, Coordinator of the Minor
Electrical and Computer Engineering

The purpose of the minor in Illumination Engineering is to help meet the need for advanced lighting expertise in the state of California, both for professionals in the field and engineers who want to provide advanced expertise so sorely needed. Lighting is a significant part of the energy being used in the state. Training engineers with expertise in lighting will provide a healthy basis for the myriad of lighting applications where energy efficient designs and technologies are important. The minor is designed to be appropriate for students in the physical sciences and engineering and engineering technology. The required course in area V is an approved elective in all engineering disciplines.

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/L	(3/1)

AREA II (Optics/Light)

General Physics/Laboratory	PHY	234/L	(3/1)
Applied Optics	PHY	344	(4)

AREA III (Energy Conservation)

Energy Management	ME	306	(4)
Applied Heating and Air Conditioning	ETM	334	(4)

AREA IV (Lighting Design)

Stage Lighting	TH	332/L	(2/1)

AREA V (Lighting Technology)

Introduction to Illumination Engineering (required)	ECE	490/L	(4/1)
Lighting Control/Design	ECE	492/L	(4/1)

MATERIALS ENGINEERING MINOR

Vilupanur A. Ravi, Coordinator of the Minor
Chemical and Materials Engineering

Materials Engineering is a field that studies the interrelationships among the properties, processing, structure, and performance of materials. The minor in Materials Engineering is available to students who satisfactorily complete the 24-unit requirement. The minor is appropriate for all engineering and science majors.

The goal of the materials engineer is to understand the structure of materials (at the micro or the nano level) to improve their properties and ultimately their performance. Materials engineers apply this knowledge in the production, selection and utilization of materials. Since engineers and scientists are called upon to work with new ideas and materials, the engineering or science graduate with a minor in materials engineering is very well prepared to respond to such a challenge and thus have a career advantage.

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 Engineering	MTE	207	(3)
or Engineering Materials.	ME	315	(4)
Materials Science and Engineering Lab	MTE	317L	(1)
or Materials Science and Selection Lab	ME	350L	(1)
Strength of Materials I	ME	218	(3)

or Aerospace Structural Mechanics I	ARO	326	(4)
Strength of Materials Lab	ME	220L	(1)
or Aerospace Structures Lab	ARO	357L	(1)
Chemical Engineering Thermodynamics I	CHE	302	(4)
or Thermodynamics I	ME	301	(4)
MTE electives	MTE	XXX	(11-12)

OCEAN ENGINEERING MINOR

_____ Coordinator of the Minor, 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-foot Research Vessel YELLOWFIN. Cal Poly Pomona facilities include a fleet of general purpose and instrumented craft, and the Fluids Laboratory.

The minor in Ocean Engineering is available to any engineering student. 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:

Marine Biology/Laboratory	BIO	330/L	(3/1)
or Marine Ecology/Laboratory	BIO	442/L	(3/2)
Ocean Electronics	ECE	434	(4)
Introduction to Ocean Engineering	EGR	230	(2)
Ocean Engineering	EGR	430	(4)
Oceanography	GSC	335	(4)

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

Special Study for UD Students	EGR	400	(1-2)
Underwater Sound	EGR	437	(4)
Special Topics	EGR	499	(1-4)
Coastal Processes	GSC	338	(4)
Basic Scuba/Laboratory	KIN	231/L	(2/2)
Joining of Materials/Laboratory	MTE	337/L	(2/1)
Corrosion and Material Degradation/Laboratory	MTE	401/L	(3/1)

DEPARTMENTS, MAJORS, MINORS, AND DEGREES

GRADUATE STUDIES

Master of Science in Engineering
Master of Science in Civil Engineering
Master of Science in Electrical Engineering
Master of Science in Engineering Management
Master of Science in Mechanical Engineering

AEROSPACE ENGINEERING

Ali R. Ahmadi, Chair
Bachelor of Science in Aerospace Engineering

CHEMICAL AND MATERIALS ENGINEERING

Vilupanur Ravi, Chair
Bachelor of Science in Chemical Engineering

CIVIL ENGINEERING

Francelina A. Neto, Interim Chair
Bachelor of Science in Civil Engineering, subplans in General Civil Engineering, Environmental Engineering, and Geospatial Engineering

ELECTRICAL AND COMPUTER ENGINEERING

Salomón Oldak, Chair
Bachelor of Science in Electrical Engineering
Bachelor of Science in Computer Engineering

ENGINEERING TECHNOLOGY

Gerald K. Herder, Chair
Bachelor of Science in Engineering Technology
Bachelor of Science in Construction Engineering Technology
Bachelor of Science in Electronics and Computer Engineering Technology

INDUSTRIAL AND MANUFACTURING ENGINEERING

Abdul B. Sadat, Chair
Bachelor of Science in Industrial Engineering
Bachelor of Science in Manufacturing Engineering

MECHANICAL ENGINEERING

Hassan Rejali, Chair
Bachelor of Science in Mechanical Engineering

ENERGY ENGINEERING MINOR

John R. Biddle, Coordinator, Energy Engineering Committee

ILLUMINATION ENGINEERING MINOR

R. Frank Smith, Coordinator, Illumination Engineering Committee

MATERIALS ENGINEERING MINOR

Vilupanur A. Ravi, Coordinator, Materials Engineering Committee

OCEAN ENGINEERING MINOR

_____, Coordinator, 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.

For all engineering courses with a prerequisite of MAT 105, this prerequisite may be satisfied by any of the following courses: MAT 105, MAT 106, MAT 112, MAT 114, MAT 115, MAT 116, MAT 130, MAT 131, MAT 132, MAT 214, MAT 215, MAT 216, or MAT 224.

For all engineering courses with a prerequisite of MAT 114, this prerequisite may be satisfied by any of the following courses: MAT 114, MAT 115, MAT 116, MAT 214, MAT 215, MAT 216, or MAT 224.

For all engineering courses with a prerequisite of MAT 115, this prerequisite may be satisfied by any of the following courses: MAT 115, MAT 116, MAT 214, MAT 215, MAT 216, or MAT 224.

For all engineering courses with a prerequisite of MAT 116, this prerequisite may be satisfied by any of the following courses: MAT 116, MAT 214, MAT 215, MAT 216, or MAT 224.

For all engineering courses with a prerequisite of ENG 104, this prerequisite may be satisfied by ENG 104 or IGE 120 or IGE 121 or IGE 122.

EGR 100/100L Engineering, Society, and You (3/1)

The development of the individual in society from an engineering perspective. The study of the integration of society and technology. Development includes: introduction to the fields of engineering and engineering technology, career planning, development of a community of learners, critical thinking, problem solving skills for lifelong learning, and ethical and professional behavior. Field trips providing exposure to the impact of technology on society. Analysis of typical problems involving technology in society and their solutions, e.g., global warming, ecological stress, etc. Guest speakers. Courses fulfill GE Area E. 3 lectures, 1 three-hour laboratory.

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. Mandatory credit/no credit grading basis. 3 hours laboratory.

EGR 102L Laboratory Practices and Procedures (1) (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. Mandatory credit/no credit grading basis. 3 hours laboratory. Prerequisite: EGR 101L.

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; resume writing. The first of a three-course sequence required for MEP students. 3 lectures/ problem-solving.

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; interviewing techniques. Development of different engineering projects; building, testing, evaluating, and making presentations on results. The second of a three-course sequence required for MEP students. 1 hour lecture, 1 two-hour activity.

EGR 112L Engineering Career Exploration II (1)

Introduction to the work environment in engineering and computer science via site visits. The third of a three-course sequence required for MEP students. 1 three-hour lab.

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 Study 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 210 Engineering Orientation for Transfer Students (2)

Introduction to the resources of the College of Engineering and the campus, as well as the expectations of the faculty in the majors/departments. Professional development, presentations, time management as required by technical majors in a quarter system school. This course is required for MEP transfer students. 2 lectures/problem-solving.

EGR/ENV/CLS 215 Introduction to Interdisciplinary GIS Studies (2)

Interdisciplinary overview of applications in geographic information system (GIS) applications. Diagnostic assessment of student skills and development of study plans. Linkage of GIS to various disciplines. 2 hours lecture/discussion.

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 Pomona's trailerable boats with 3D sonar systems and other equipment. 2 lectures/problem-solving.

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. Instruction is by lecture, laboratory, or a combination.

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: ENG 104, completion of General Education Areas B1, B2, and B4 requirements.

EGR 302/302A Visual Basic for Geographic Information Systems (3/1)

Logical methods and techniques in algorithm development. The Visual Basic environment and Visual Basic programming. Structure of object oriented programs. Concept of class organization and manipulation. Programming Geographical Information Systems (GIS) related algorithms using Visual Basic and their integration in the GIS environment. 3 hours lecture, 2 hours activity. Pre-requisite: MAT106 or STA120.

EGR 322 California Land and Boundaries Law (4)

Study of historical, social, political geographical and economic aspects of real property and boundary law in America. Emphasis on social and historical aspects of the extent and limits of property ownership. Synthesis of the principles and process used to establish property boundaries. Course fulfills GE Synthesis D4. 4 lecture problems. Prerequisites: Completion of all GE Area A, D1, D2, and D3 requirements.

EGR 400 Special Study 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: ENG 104.

EGR/BUS 401 Product Liability and Patents (4)

Product liability and the patent process will be covered in this class. This is an interdisciplinary course where the various ethical, technological, safety, economic tradeoff considerations are given to new products and ideas by the student. Case studies will be given to strengthen the students' understanding of how to apply these concepts. The use of

computer software is required for classroom presentations. This course fulfills GE Areas C4 Humanities or D4 Social Science. Prerequisites: Completion of GE Area A and 2 lower division sub-areas in Area C or Area D.

EGR 402 Ethical Considerations in Technology and Applied Science (4)

This course is team taught by an engineering instructor and a philosophy instructor. Explores the ethics of engineers: values, ethical theory and practice, moral reasoning morality in law and codes, professional standards and societies. Case studies. Course fulfills GE Interdisciplinary Synthesis B5 or C4. Prerequisites: One GE course from each of the following Sub-areas: A1, A2, A3 and B2, B3 and C2.

EGR 403 Asset Allocation in Technical Decision Making (4)

Economic theory of capital allocation decisions. Current and relevant views of managerial economics used to present a unified theory of capital allocation appropriate to private, public and governmental entities. Integrated application of economic and operations analysis to managerial problem-solving and decision making processes. Study of inflation and tax consequences on economic decisions. Open to all majors. Course fulfills GE Interdisciplinary Synthesis B5 or C4. Four 1-hour lecture discussions. Prerequisites: Completion of GE Area A and sub-areas B1, B2, B4, and D1, D2, D3.

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 lectures/problem-solving. Prerequisites: ENG 104, upper division standing in the College of Engineering.

EGR 437 Underwater Sound (4)

Principles of underwater sound propagation and reception. The sonar equation. Transducer design and calibration. 4 lectures/problem-solving. Prerequisite: ENG 104, and upper division standing.

EGR 445/BUS 445 Role of Design Professionals in Society (4)

The unique role of design professionals in society, and the associated privileges and responsibilities. Social, economic, historical, legal, and political aspects of professional practice, as well as ethics, social responsibility, regulatory requirements, professional liability, and the consequences of failures. Course fulfills GE Synthesis D4. 4 lecture discussions. Prerequisites: Completion of all GE Area A, D1, D2, and D3 requirements.

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. Prerequisites: ENG 104, and upper division standing.

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: ENG 104 and senior standing.

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

Part-time or full-time industry work experience of a nature that relates academic engineering theory to practice. To be taken in sequence. Maximum 16 units. Prerequisites: ENG 104, junior standing, good academic standing, Engineering major, and co-op coordinator consent.

EGR/SCI 475 Beyond Curie: Women in Math, Science, and Engineering (4)

Social implications and history of the contribution of women in math, science, and engineering. Examination of how socially defined identities affected the careers of female scientists. Combined with examination of current and specific topics in mathematics, science, and engineering. 4 hours seminar. Prerequisites: One course from each of the following Sub-areas: A1, A2, A3 and B1, B2, B4 and D1, or D2, and D3. Fulfills GE Interdisciplinary Synthesis sub-area B5 or D4.

AG/EGR 481, 482 Project Design Principles and Applications (2), (2)

Selection and completion of scientific/technological synthesis application project under faculty supervision. Multidisciplinary team project. Projects which graduates solve in discipline of practice. Both formal written and oral reports. Minimum time commitment: 120 hours. Course fulfills GE Synthesis B5. Prerequisites: One GE course from each of the following Sub-areas: A1, A2, A3 and B1, B2, B4 and upper division standing.

EGR/SCI 484 Science and Technology Seminar (4)

Issues to be explored will include, but not be limited to: the impact of science and technology on civilization and human values; ecological issues; history of science and technology; scientific method and reasoning; heath and diseases; medical technology and its ethical implications; general systems theory and its application. Prerequisites: One GE course from each of the following Sub-areas: A1, A2, A3 and B1, B2, B4. Fulfills GE Synthesis sub-area B5.

EGR/ENV/CLS 494/A Interdisciplinary Project in Geographic Information Systems I (1/1)

Problem-solving skills using GIS technology in a Fall/Winter/Spring sequence. Students design, manage and develop GIS projects in an interdisciplinary setting. Issue related to ethics, decision making, interdisciplinary applications and the visual display of information are addressed. 1 lecture discussion, 2 hours activity.

EGR/ENV/CLS 495/A Interdisciplinary Project in Geographic Information Systems II (1/1)

Problem-solving skills using GIS technology in a Fall/Winter/Spring sequence. Students design, manage and develop GIS projects in an interdisciplinary setting. Issue related to ethics, decision making, interdisciplinary applications and the visual display of information are addressed. 1 lecture discussion, 2 hours activity. Pre-requisite: EGR/ENV/CLS 494/A.

EGR/ENV/CLS 496/A Interdisciplinary Project in Geographic Information Systems III (1/1)

Problem-solving skills using GIS technology in a Fall/Winter/Spring sequence. Students design, manage and develop GIS projects in an interdisciplinary setting. Issue related to ethics, decision making, interdisciplinary applications and the visual display of information are addressed. 1 lecture discussion, 2 hours activity. Pre-requisite:

EGR/ENV/CLS 495/A.

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. Instruction is by lecture, laboratory or a combination. Prerequisite: ENG 104.

AEROSPACE ENGINEERING

www.csupomona.edu/aro

Ali R. Ahmadi, Chair

Subodh Bhandari
Steven K. Dobbs
Donald L. Edberg
Gabriel G. Georgiades

The Aerospace Engineering program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. The vision of the Aerospace Engineering Department is to produce nationally recognized aerospace graduates who can contribute to achievements in national defense, space exploration, commercial aerospace, aeronautics, and academia.

The mission of the Aerospace Engineering Program is to provide an education by hands-on application of theory to produce graduates for a diverse society who can contribute immediately, effectively and ethically to the development of aerospace products and possess the educational foundations for their career growth in industry, and academia, with innovation and leadership.

Traditionally the aerospace engineer has been involved with the design and development of high speed vehicles such as aircraft, missiles and spacecraft. Over the 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 aerodynamics and heat transfer, structural mechanics, control system theory and vehicle dynamics using systems engineering processes. Often the aerospace engineer is confronted with problems that cannot be fully defined but, in spite of this, require imaginative and sophisticated solutions.

The graduates of Aerospace Engineering will be practicing professionals who exhibit these Program Educational Objectives:

A. Demonstrate their knowledge of aerodynamics, aerospace materials, aircraft and spacecraft structures, aircraft and space propulsion, flight mechanics, stability and control systems, orbital mechanics, space environment, attitude determination and control, telecommunications, and design competence of aircraft and spacecraft using systems engineering principles;

B. Apply hands-on application of theory in laboratory, field experience and independent study opportunities involving teamwork and exposure to modern engineering analytical and computational tools;

C. Utilize a comprehensive educational foundation that emphasizes application based analysis and problem-solving, exposure to open-ended problems and engineering while fostering teamwork, communication skills, innovation, leadership, lifelong learning skills and individual ethnical professionalism in graduate studies and careers in aerospace engineering.

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 Pomona. The community college student planning to transfer into this department should consult a school counselor or department to determine which courses meet the program requirements.

The Student Outcomes at the time of graduation are:

(a) An ability to apply knowledge of mathematics, science, and engineering, especially with an understanding of physics, chemistry, mathematics, material science, electrical circuits, controls, and software required to address real-world engineering problems;

(b) An ability to design and conduct experiments, as well as to analyze and interpret data especially for testing of aerospace structural elements, aerodynamic components and systems, aerospace propulsion systems, spacecraft, launch vehicles and flight control systems including autonomous controls;

(c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability with the ability to turn data into meaningful engineering design using systems engineering life cycle development processes especiallly for the design of complex systems such as aircraft, launch vehicles and spacecraft from a conceptual design perspective and formulate the systems engineering life cycle development process including business case modeling;

(d) An ability to function on multidisciplinary teams;

(e) An ability to identify, formulate, and solve engineering problems with an understanding of engineering science fundamentals that enables them to examine real world engineering problems for the underlying physical principles and decide on appropriate methods of solution especially applied to analyzing aerospace structural elements, aerodynamic components and systems, aerospace propulsion systems, spacecraft, launch vehicles and trajectory flight control systems including autonomous controls;

(f) An understanding of professional and ethical responsibility and an awareness of environmental and quality concerns of the engineering profession;

(g) An ability to communicate effectively including good oral, written and graphic communications skills;

(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context with an understanding of the role of the engineer in industry, government, and society.

(i) A recognition of the need for, and an ability to engage in life-long learning;

(j) A knowledge of contemporary issues;

(k) An ability to use the techniques, skills, and modern engineering computational tools.

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 national aerospace engineering honor society.

REQUIRED CORE COURSES

Required of all students. A 2.0 cumulative GPA is required in core courses for the major in order to receive a degree in the major.

Introduction to Aeronautics	ARO	101L	(1)
Introduction to Astronautics	ARO	102L	(1)
Introduction to Aerospace Propulsion	ARO	103L	(1)
Fundamentals of Aeronautics	ARO	202L	(1)
Fundamentals of Astronautics	ARO	203L	(1)
Fluid Dynamics	ARO	301	(4)
Low-Speed Aerodynamics and Performance	ARO	305	(4)

Astronautics	ARO	309	(3)
Gas Dynamics	ARO	311	(3)
Aircraft Jet Propulsion	ARO	312	(4)
Aerospace Feedback Control Systems	ARO	322/L	(3/1)
Aerospace Structural Mechanics I	ARO	326/L	(3/1)
Aerospace Structural Mechanics II	ARO	327	(3)
Aerospace Structural Analysis and Design	ARO	329	(3)
Fluid Dynamics/Heat Transfer Lab	ARO	351L	(1)
High-Speed Aerodynamics Lab	ARO	352L	(1)
Aerospace Structures Laboratory	ARO	357L	(1)
Heat, Mass and Moment Transfer	ARO	401	(4)
High-Speed Aerodynamics	ARO	404	(3)
Aircraft Stability and Control	ARO	405	(4)
Advanced Dynamics and Vibrations of Aerospace Systems	ARO	406	(4)
Low-Speed Aerodynamics Laboratory	ARO	435L	(1)
Senior Project	ARO	461	(2)
Senior Project	ARO	462	(2)
Aerosciences	ARO	490L	(1)
Aerospace Vehicle Design Lab I	ARO	491L	(2)
Aerospace Vehicle Design Lab II	ARO	492L	(2)
Aerospace Vehicle Design Lab III	ARO	493L	(2)

ELECTIVE CORE COURSES

Approved Technical Electives . . . . . (12)

REQUIRED SUPPORT COURSES

The following major support courses should be used to satisfy the indicated GE requirements. If these courses are not used to satisfy GE, the total units to degree may be more than 198 units.

Fundamentals of Systems Engineering	ARO	201L	(1)
CHE Thermodynamics I	CHE	302	(4)
or Thermodynamics I	ME	301	(4)
General Chemistry	CHM	121	(3)
General Chemistry Lab (B3)	CHM	121L	(1)
Elements of Electrical Engineering	ECE	231/L	(3/1)
Ethical Considerations in Technology and Applied Science (C4)	EGR	402	(4)
Analytic Geometry and Calculus I (B4)	MAT	114	(4)
Analytic Geometry and Calculus II	MAT	115	(4)
Analytic Geometry and Calculus III	MAT	116	(4)
Calculus of Several Variables I	MAT	214	(3)
Calculus of Several Variables II	MAT	215	(3)
Differential Equations	MAT	216	(4)
or Elem. Linear Algebra & Differential Equations	MAT	224	(4)
Mathematical Analysis of Engineering Problems	MAT	318	(3)
Vector Statics	ME	214	(3)
Vector Dynamics	ME	215	(4)
Materials Science and Engineering	MTE	207	(3)
General Physics (B1, B3)	PHY	131/L	(3/1)
General Physics	PHY	132/L	(3/1)
General Physics	PHY	133/L	(3/1)

GENERAL EDUCATION REQUIREMENTS

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

Area A Communication and Critical Thinking (12 units)

1. Oral Communication
2. Written Communication
3. Critical Thinking

Area B Mathematics and Natural Sciences (16 units)

1. Physical Science
2. Biological Science
3. Laboratory Activity
4. Math/Quantitative Reasoning
5. Science and Technology Synthesis

Area C Humanities (16 units)

1. Visual and Performing Arts
2. Philosophy and Civilization
3. Literature and Foreign Languages
4. Humanities Synthesis

Area D Social Sciences (20 units)

1. U.S. History, Constitution, and American Ideals
2. History, Economics, and Political Science
3. Sociology, Anthropology, Ethnic, and Gender Studies
4. Social Science Synthesis

Area E Lifelong Understanding and Self-development (4 units)

Lifelong Understanding

COURSE DESCRIPTIONS

ARO 101L Introduction to Aeronautics (1)

History of fixed- and rotary-wing aircraft development; characteristics of current aircraft. Contributions of aerospace engineering to society. Units and dimensions, dimensionless coefficients. Forces, pressures, generation of lift. Wind tunnel test project. Radio-controlled aircraft project. Aerospace structural materials. Preliminary aircraft sizing. 1 three-hour laboratory. Corequisite: MAT 114

ARO 102L Introduction to Astronautics (1)

History of missile, rocket, and spacecraft development; characteristics of current launch vehicles and spacecraft. The role of the aerospace engineer in industry, government, and the university. Launch performance, trajectories, and orbits. Solid-propelled rocket project. Spacecraft mission design and configuration. 1 three-hour laboratory. Corequisite: MAT 114.

ARO 103L Introduction to Aerospace Propulsion (1)

History of aircraft engine and rocket development; characteristics of current aircraft piston, turbine and rocket engines. Ethical factors, standards and expectations in aerospace engineering. Generation of thrust. Propulsion system performance. Jet engine test project. Compressed-air thrust project. 1 three-hour laboratory. Corequisite: MAT 114.

ARO 127L Aerospace Engineering Computer Graphics Laboratory (2)

Computer-aided graphics and engineering design fundamentals. Sketching, line drawing, dimensioning, simple wire frame, solid modeling and projection theory. Airplane general arrangement, layout, and inboard profile drawings. 2 three-hour laboratories.

ARO 201L Fundamentals of Systems Engineering (1)

History and purpose of systems engineering. System design exercise. Team design. Needs analysis; consideration of ethical, social, economic contemporary issues and environmental factors. System-design process. Role of the engineer in system design. Program planning and control. Engineering documentation. Principles of technical writing. 1 three-hour laboratory. Prerequisite: ENG 104 or IGE 120 or IGE 121 or IGE 122, C or

better in MAT 114.

ARO 202L Fundamentals of Aeronautics (1)

Aircraft manufacturing methods. Aerodynamic drag. Aircraft controls and piloting techniques. Aircraft performance. Aeroelasticity concepts. Preliminary aircraft design. Wind tunnel test project. 1 three-hour laboratory. Prerequisite: C or better in ARO 101L.

ARO 203L Fundamentals of Astronautics (1)

Orbits and trajectories. Launch windows and rendezvous. Spacecraft mission analysis. Spacecraft guidance and control techniques. Booster design. Boost and reentry trajectory simulation. Atmospheric entry. 1 three-hour laboratory. Prerequisite: C or better in ARO 102L.

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. Instruction is by lectures/problem-solving, laboratory, or a combination.

ARO 301 Fluid Dynamics (4)

Pressure distribution in a fluid. Control volume and differential approaches to fluid flow analysis. Development and application of Navier-Stokes equations. Potential flow theory. Dimension analysis and similarity. Viscous flow in ducts. Working knowledge of a high-level computer language is required. 4 lectures/problem-solving. Prerequisites: ENG 104 or IGE 120 or IGE 121 or IGE 122, C or better in MAT 216 or MAT 224. Corequisites: MAT 318, CHE 302 or ME 301, and ME 215.

ARO 305 Low-Speed Aerodynamics and Performance (4)

Boundary-Layer theory. Biot-Savart law. Panel methods. Thin airfoil theory. Lifting-line theory. Numerical aerodynamics of airfoils and wings. Skin friction drag. Induced drag. Propeller theories. Airplane performance. 4 lectures/ problem-solving. Prerequisite: C or better in ARO 301.

ARO 309 Astronautics (3)

Space mission and trajectory design. Kepler's laws. Orbits, hyperbolic escape trajectories, interplanetary transfers, gravity assists. Special orbits including geostationary, Molniya, sun-synchronous. 3 lectures/problem-solving. Prerequisites: ENG 104 or IGE 120 or IGE 121 or IGE 122, C or better in ME 215.

ARO 311 Gas Dynamics (3)

Governing equations of fluid dynamics for compressible flow. Normal shock waves. Oblique shock waves. Expansion waves. Quasi-one-dimensional flow. Fanno flow. Rayleigh flow. Unsteady wave motion. High-temperature gases and flows. Applications. 3 lectures/problem-solving. Prerequisite: C or better in ARO 301. Corequisite: CHE 302 or ME 301.

ARO 312 Aircraft Jet Propulsion (4)

Ideal cycle analysis of ramjet, turbojet, turbofan and turboprop. After burning. Cycle analysis with losses. Nonrotating components: diffusers, nozzles and combustors. Compressor, fans and turbines. Component matching and engine performance. Aircraft engine noise. Hypersonic engines. 4 lectures/problem-solving. Prerequisite: C or better in ARO 311.

ARO 322/L Aerospace Feedback Control Systems/Laboratory (3/1)

Mathematical models of systems. Laplace transformations. 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. 3 lectures/problem-solving; 1 three-hour laboratory. Prerequisites: ENG 104 or IGE 120 or IGE 121 or IGE 122, C or better in MAT 216 or MAT 224. Corequisite: MAT 318.

ARO 326/L Aerospace Structural Mechanics I/Laboratory (3/1)

Vector analysis of two-dimensional kinetic motion of aerospace vehicles. Plane kinematics including absolute and relative motion. Force and moment equilibrium in three dimensions using free body diagrams and vector algebra. Internal loads in engine mount, landing gear and fabric-covered wing structures. Shear and bending-moment diagrams. Centroids, center of gravity, moments of area, and moments of inertia. Material properties, stress-strain relationships, Mohr's circle, strain gages. Analysis of stress in members subject to axial, torsional, bending, and shearing loading. 3 lectures/problem-solving; 1 three-hour laboratory. Prerequisites: C or better in PHY 131/L. Corequisite: MAT 214.

ARO 327 Aerospace Structural Mechanics II (3)

External loads on aircraft, inertia forces and load factors, design loads, factor of- and margin of-safety, V-n diagrams. Strain energy. Analysis of deformation in members subject to axial, torsional, bending, shearing, and combined loading using Castigliano's theorem. Statically indeterminate structures. Pressure vessels, yield criteria. Shear flow in closed and open thin-walled sections. Bending and shear stresses in beams with unsymmetrical cross-sections. Principles and analysis of stressed skin construction. 3 lectures/problem-solving. Prerequisite: C or better in ARO 326.

ARO 328 Aerospace Structures (4)

Aerospace structural analysis in the design process. Elementary aeroelasticity. Axial constraint. Design of members in tension, torsion, bending, or shear. Design of compression members. Design of webs in shear. Detailed design. 4 lectures/problem-solving. Prerequisite: C or better in ARO 329.

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 lectures/problem-solving. Prerequisite: C or better in ARO 327.

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

Selected experiments in fluid dynamics and heat transfer in aerospace engineering, such as vortex flows, transition from laminar to turbulent flow and potential flow simulations. Team work. Laboratory report writing. 1 three-hour laboratory. Corequisite: ARO 401.

ARO 352L High-Speed Aerodynamics Laboratory (1)

Selected experiments in high-speed aerodynamics using a supersonic wind tunnel and a computer-based data acquisition system. Team work. Laboratory report writing. 1 three-hour laboratory. Prerequisites: C or better in ARO 312, ARO 404.

ARO 357L Aerospace Structures Laboratory (1)

Experimental stress analysis of structures subject to axial, torsional, bending, shearing and combined loading. Statically indeterminate structures. Application of the electrical resistance strain gage and

photoelastic methods. Technical communication and engineering report writing. 1 three-hour laboratory. Prerequisite: C or better in ARO 326.

ARO 400 Special Study 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: ENG 104, or IGE 120 or IGE 121 or IGE 122.

ARO 401 Heat, Mass and Momentum Transfer (4)

Conduction, convection and radiation heat transfer. Heat diffusion equation. 1-D, 2-D and 3-D conduction. Transient conduction. Finite-difference methods. Heat, mass and momentum transfer by convection in external and internal flows. Radiation heat transfer analysis. 4 lectures/problem-solving. Prerequisite: C or better in 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. Working knowledge of a high-level computer language required. 4 lectures/problem-solving. Prerequisites: ENG 104 or IGE 120 or IGE 121 or IGE 122, C or better in MAT 216 or MAT 224.

ARO 404 High-Speed Aerodynamics (3)

Governing laws of high-speed flows. The velocity potential equation. Taylor-Maccoll equation. Conical flow. Compressibility correction rules for subsonic flows. Transonic flow. Wing sweep. Area ruling. Airfoils and wings in supersonic flight. Wave drag. Hypersonic flight. Design considerations for high-speed aircraft. 3 lectures/problem-solving. Prerequisite: C or better in ARO 311.

ARO 405 Aircraft Stability and Control (4)

Static Stability. Stability derivatives. Airplane controls. Airplane equations of motion. Dynamic stability. Transfer functions. Airplane response and simulation. Flying qualities. Automatic control and autopilots. 4 lectures/problem-solving. Prerequisites: C or better in ARO 305, 322/322L.

ARO 406 Advanced Dynamics and Vibrations of Aerospace Systems (4)

Vector dynamics of aerospace systems; 3-D particle and rigid-body dynamics; linear and angular momentum; Lagrangian dynamics; equations of motion and vibrations of single and multi-degree of freedom and continuous systems; method of Euler; introduction to space vehicle motion. 4 lectures. Prerequisites: ENG 104 or IGE 120 or IGE 121 or IGE 122, C or better in ME 215, MAT 318.

ARO 407 Space Flight Dynamics (4)

Three-dimensional rigid body motion of launch vehicles and spacecraft. Performance analyses and simulations. Estimation of gravity, drag, propulsion, and maneuvering losses. Gravity-turn and other ascent trajectories. Optimization techniques. Trajectory analysis computer codes. 4 lectures/problem-solving. Prerequisite: C or better in ARO 406.

ARO 408 Finite-Element Analysis of Aerospace Structures (4)

Theoretical development of one- and two-dimensional finite elements. Analysis and design of truss, frame and semimonocoque structures using the direct stiffness and energy formulation of the finite element method. Computer-aided design and analysis projects using commercial finite element software. 4 lectures/problem-solving. Prerequisite: C or better in ARO 326.

ARO 409 Spacecraft Dynamics and Control (4)

Euler's equations. Rigid body motion, including inertia tensors. Spin and ual-spin spacecraft stability. De-spinning of spacecraft. Coning maneuvers. Closed-loop attitude control via thrusters, reaction wheels, control-moment gyros. Phase-plane diagrams. Bang-bang control. 4 lectures/problem-solving. Prerequisites: C or better in ARO 309, 406.

ARO 412 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 lectures/problem-solving. Prerequisite: C or better in ARO 305.

ARO 414 Rocket Propulsion (4)

Principles of rocket propulsion. Combustion chemistry. Liquid-fuel rocket engines. Solid-fuel rocket engines. Electrical propulsion. 4 lectures/problem-solving. Prerequisite: C or better in ARO 311.

ARO 418 Space Enviroment (4)

The space environment and its impact on spacecraft operations. Non-uniform gravitational fields, aerodynamic drag effects including aerobraking, solar heating and pressure, radiation, electrical issues, orbital debris. Considerations for special orbits. On-board disturbances. Spacecraft thermal control, life support systems. 4 lectures/ problem-solving. Prerequisite: C or better in ARO 309.

ARO 419 Computational Fluid Dynamics (4)

Classification of partial differential equations. Elements of finite-difference methods. Stability analysis. Algorithms for numerical solution of parabolic, elliptic and hyperbolic partial differential equations. Finite volume and finite element methods. Applications in fluid dynamics, gas dynamics and heat transfer. Working knowledge of a high-level computer language required. 4 lectures/problem-solving. Prerequisites: C or better in ARO 301. Corequisite: ARO 311.

ARO 420 Aerospace Engineering Management (4)

Introduction to various management roles in technical fields. Gain insight into the roles of Program Management, Project Management and Functional Management in aerospace companies. Understand government agencies and customer interactions. Role of discretionary R&D and proposal development. Career path development and expected skills requirements. Program management plan; team project linked to ARO 492L/493L. 4 lectures/problem-solving. Prerequisite: ENG 104 or IGE 120 or IGE 121 or IGE 122. Consent of Instructor.

ARO 421 Helicopter Aerodynamics and Performance (4)

The development of rotary-wing aircraft and the helicopter. Review of blade element/momentum theory; hovering and vertical flight theory; autorotation; performance in forward flight. 4 lectures/problem-solving. Prerequisite: C or better in ARO 305, and ARO 405.

ARO 422 Advanced Aerospace Control Systems (4)

Review of classical controls. Control system design. Compensators. Nonlinear systems. Describing functions. 4 lectures/problem-solving. Prerequisite: C or better in 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 lectures/problem-solving. Prerequisite: C or better in ARO 305.

ARO 427 Aeroacoustics and Structural Dynamics (4)

Vibrational concepts of acoustics: time and frequency domain analysis, free and forced motion of single and multi-degree of freedom systems, random inputs, and approximation methods. Classical vibration control. Structural wave motion: aeroelasticity, divergence, and flutter. 4 lectures. Prerequisite: C or better in ARO 327 and ME 215.

ARO 431 Intermediate Finite-Element Analysis of Aerospace Structures (4)

Structural dynamics, structural stability and advanced elements in the finite element method. Basic theory will be augmented strongly by computer applications. 4 lectures/problem-solving. Prerequisite: C or better in ARO 408.

ARO 435L Low-Speed Aerodynamics Laboratory (1)

Test plan formulation. Pressure, temperature and loads measurements. Test section calibration and correction. Subsonic wind tunnel applications. 1 three-hour laboratories. Corequisite: ARO 305.

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 lectures/problem-solving. Prerequisite: C or better in 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: ENG 104 or IGE 120 or IGE 121 or IGE 122, senior standing in major.

ARO 490L Aerosciences (1)

Comprehensive review of basic principles of aerodynamics, propulsion, vehicle dynamics, astronautics, and structures for application in the conceptual and preliminary design of aerospace vehicles. A comprehensive exam will be administered on the above subjects. 1 three-hour laboratory. Corequisite: ARO 491L or ARO 492L.

ARO 491L Aerospace Vehicle Design Laboratory I (2)

Aerospace vehicle design philosophy. Oral and written presentations of system design. Environmental considerations. Trade-studies; statistical design, parameter estimation. Manufacturing, facilities, cost, aircraft, spacecraft. 2 three-hour laboratories. Prerequisites: C or better in ARO 309, 312, 401, 404, 405.

ARO 492L Aerospace Vehicle Design Laboratory II (2)

Conceptual design of aerospace vehicles. Design tradeoffs in multi-disciplined systems. Participation in team design projects. Oral and written presentations of system design. Oral briefing to an industry/government review panel. 2 three-hour laboratories. Prerequisites: C or better in ARO 406, ARO 491L.

ARO 493L Aerospace Vehicle Design Laboratory III (2)

Preliminary design of aerospace vehicles. Completion of ARO 492L team design projects. Preparation of final project report together with an oral briefing to an industry/government review panel. 2 three-hour laboratories. Prerequisite: C or better in ARO 329, ARO 492L.

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. Instruction is by lecture, laboratory, or a combination. Prerequisite: ENG 104 or IGE 120 or IGE 121 or IGE 122.

CHEMICAL AND MATERIALS ENGINEERING

www.csupomona.edu/~cme

Vilupanur Ravi, Chair

Winny Dong	Mingheng Li
Barbara A. Hacker	Thuan K. Nguyen
Lloyd Lee	Cordelia Ontiveros

The Department of Chemical and Materials Engineering is actively pursuing outcomes assessment to evaluate its effectiveness in promoting student learning and achieving its vision and objectives. The department welcomes input on the following statement of our vision and educational objectives.

The mission of the Chemical Engineering program is to prepare baccalaureate graduates with the skills necessary to contribute through their professional careers to a highly technical society that is global in scope, while paying particular attention to the needs of the State of California. The philosophy of the Chemical Engineering program is to provide a strong theoretical foundation coupled with practical application of that knowledge, which is consistent with the missions of the College of Engineering and the University.

The educational outcomes of the Chemical Engineering Program are to develop the abilities of our students to:

A. critically analyze engineering problems and find feasible solutions through the application of math, chemistry, physics and engineering fundamentals and the use of engineering materials and modern computational tools;

B. effectively search the literature, design and conduct experiments and analyze and interpret laboratory and plant data;

C. demonstrate the grasp of basic principles underlying stoichiometry, thermodynamics, transport phenomena, unit operations and chemical reaction engineering;

D. design and control chemical engineering equipment and processes with attention to economics, the environment, health and safety;

E. function as practicing engineers including the ability to communicate (written and oral) effectively, work collaboratively, learn independently, act appropriately in professional duties, and plan and execute projects successfully, and

F. understand contemporary issues and the impact of engineering solutions on society, and the ethical considerations of engineering decisions.

CHEMICAL ENGINEERING

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 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 program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

The chemical engineering curriculum in addition to a sound foundation in general education includes basic courses in chemistry, physics, mathematics, and materials, electrical, and mechanical engineering. In addition, coursework in the major includes computer programming, engineering statistics, material and energy balances, transport phenomena, unit operations, process control, process synthesis and design, 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. Student project opportunities enable students to develop essential planning, experimenting and reporting skills in individual or theme-based projects. 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.

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, one year of college chemistry, and one year of college physics (with laboratory) prior to beginning the program at Cal Poly Pomona. 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 (AIChE), International Society of Pharmaceutical Engineers (ISPE), American Society for Materials (ASM), and the Society for the Advancement of Materials and Process Engineering (SAMPE). Qualified students are invited to join the student chapter of Omega Chi Epsilon, the chemical engineering honor society.

REQUIRED CORE COURSES

Required of all students. A 2.0 cumulative GPA is required in core courses in order to receive a degree in the major.

Introduction to Chemical and Materials Engineering	CHE	131/141L	(2/1)
CHE Analysis/Laboratory	CHE	132/142L	(2/1)
CHE Data Analysis and Design of Experiments/Laboratory	CHE	143L	(1)
Stoichiometry I	CHE	201/211L	(3/1)
Stoichiometry II	CHE	202/212L	(3/1)
Chemical Engineering Thermodynamics I	CHE	302	(4)
Chemical Engineering Thermodynamics II	CHE	303	(4)
Kinetics and Reactor Design	CHE	304	(4)
Momentum Transport	CHE	311	(4)
Energy Transport	CHE	312	(3)
Mass Transport	CHE	313	(3)
Transport Laboratory I	CHE	322L	(1)
Transport Laboratory II	CHE	333L	(1)
Unit Operations I	CHE	425/435L	(3/1)
Process Controls	CHE	426	(3)
Process Controls Laboratory	CHE	436L	(1)
Chemical Process Synthesis and Design I	CHE	441/451L	(4/1)
Chemical Process Synthesis and Design II	CHE	442/452L	(3/1)
Chemical Process Synthesis and Design III	CHE	443/453L	(3/1)
Undergraduate Project	CHE	463	(2)

REQUIRED SUPPORT COURSES

The following major support courses should be used to satisfy the indicated GE requirements. If these courses are not used to satisfy GE, the total units to degree may be more than 198 units.

General Chemistry	CHM	121	(3)
General Chemistry Lab (B3)	CHM	121L	(1)
General Chemistry	CHM	122/L	(3/1)
General Chemistry	CHM	123	(3)
Organic Chemistry	CHM	314/317L	(3/1)
Organic Chemistry	CHM	315	(3)
Organic Chemistry	CHM	316	(3)
Elements of Electrical Engineering	ECE	231/L	(3/1)
Ethical Considerations in Technology and Applied Science (C4)	EGR	402	(4)
Project Design Principles and Applications (B5)	EGR	481/482	(2/2)
Analytic Geometry and Calculus I (B4)	MAT	114	(4)
Analytic Geometry and Calculus II	MAT	115	(4)
Analytic Geometry and Calculus III	MAT	116	(4)
Calculus of Several Variables I	MAT	214	(3)
Calculus of Several Variables II	MAT	215	(3)
Differential Equations	MAT	216	(4)
or Elem. Linear Algebra & Differential Equations	MAT	224	(4)
Vector Statics	ME	214	(3)
Materials Science and Engineering	MTE	207	(3)
Materials Science and Engineering Laboratory	MTE	317L	(1)
Corrosion and Materials Degradation	MTE	401/L	(3/1)
General Physics (B1, B3)	PHY	131/L	(3/1)
General Physics	PHY	132/L	(3/1)
General Physics	PHY	133/L	(3/1)

ELECTIVE SUPPORT COURSES

Upper Division MTE/CHE Elective . . . . . (3)

Select 4 units from any of the following list: . . . . . (4)

Physical Chemistry	CHM	311	(3)
Physical Chemistry	CHM	312	(3)
Physical Chemistry	CHM	313	(3)
Elements of Biochemistry	CHM	321/L	(3/1)
Biochemistry	CHM	327/L	(3/1)
Physical Chemistry Lab	CHM	352L	(2)
Physical Chemistry Lab	CHM	353L	(2)

GENERAL EDUCATION REQUIREMENTS

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

Area A (12 units)

1. Oral Communication
2. Written Communication
3. Critical Thinking

Area B (16 units)

1. Physical Science
2. Biological Science
3. Laboratory Activity
4. Math/Quantitative Reasoning
5. Science and Technology Synthesis*

Area C (16 units)

1. Visual and Performing Arts
2. Philosophy and Civilization
3. Literature and Foreign Languages
4. Humanities Synthesis*

Area D (20 units)

1. U.S. History, Constitution, and American Ideals
2. History, Economics, and Political Science
3. Sociology, Anthropology, Ethnic, and Gender Studies
4. Social Science Synthesis*

Area E (4 units)

Lifelong Understanding and Self-development

*Consult Department

CHEMICAL ENGINEERING COURSE DESCRIPTIONS

Lecture and laboratory courses listed together are to be taken concurrently.

CHE 131/141L Introduction to Chemical Engineering/Laboratory (2/1)

Introduction to the professions of Chemical and Materials (CME) engineering and CME analysis. Analysis of selected processes and discussions of contemporary issues and their impacts on society. Use of computer tools to solve engineering problems. Process variables and basic techniques of material balance. 2 lectures/problem-solving, 1 three-hour laboratory. Prerequisites: English remediation completed or not required, MAT 105 or equivalent.

CHE 132/142L Chemical Engineering Analysis/Laboratory (2/1)

Introduction to data analysis and experimental design using statistical concepts and techniques applied to chemical and materials engineering systems. Analysis of plant and laboratory data. Multiple regression. Correlations and significance of correlations. Analysis of variance. Introduction to statistical process control. 2 lectures/problem solving, 1 three-hour laboratory. Prerequisites: English and math remediation completed or not required.

CHE 143L Chemical Engineering Data Analysis and Design of Experiments Laboratory (1)

Introduction to the use of instrumentation to monitor Chemical Engineering processes. Measurement of the properties of materials. Introduction to design of experiments. 1 three-hour laboratory. Prerequisite: CHE 132/142L or equivalent.

CHE 201/211L Stoichiometry I/Laboratory (3/1)

Material balances for chemical and materials engineering processes. Use of process flow diagrams for plant mass balance calculations. Solving multi-component mass balance, simple and multiple mixing or separation problems, and chemical reaction problems including recycle and equilibrium. Use of CHE data sources. Introduction to energy balances. Plant trip, 3 lecture/problem solving and 1 three-hour computational laboratory. Prerequisites: MAT 115, and C- or better in CHM 121.

CHE 202/212L Stoichiometry II/Laboratory (3/1)

Analysis of single and multiple phase systems for chemical and materials engineering systems. Energy balances for both nonreactive and reactive systems. A plant trip and the use of the computer for energy balance analysis of nonreactive, reactive, and transient processes. Application of stoichiometry to environmental systems. 3 lectures/problem solving and 1 three-hour laboratory, Prerequisites: C- or better in CHE 201 and CHE 211L; C- or better in MAT 216 or MAT 224.

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. Instruction is by lecture, laboratory, or a combination.

CHE 301 Applied Mathematics in Chemical and Materials Engineering (3)

A study in the application of basic linear algebra, derivative, and integral concepts to solve chemical and materials engineering problems. Use of first-order ordinary differential equations to solve transient materials and energy balances. 3 lectures/problem-solving. Prerequisites: ENG 104 or equivalent, C- or better in MAT 216 and C- or better in CHE 202 and 212L.

CHE 302 Chemical Engineering Thermodynamics I (4)

The study of classical thermodynamics from both a chemical and materials engineering perspective. Energy and its transformations; heat and work effects; first and second law analysis; property relationships; equilibrium and phase behavior; equations of state; heat engines, heat pumps, steam power plant cycles, refrigeration cycles, gas power cycles. Ideal gas heat capacity. 4 lectures/problem-solving. Prerequisites: MAT 214 and PHY 132/L.

CHE 303 Chemical Engineering Thermodynamics II (4)

Phase equilibria of ideal and non-ideal systems. Concepts of electrochemistry fugacity, activity, and activity coefficient. Group contributions. Calculation of thermodynamic properties from experimental data. Enthalpy changes of mixing and phase changes. Microscopic thermodynamics and statistical mechanics applied to macroscopic properties and behavior of materials. Chemical reaction equilibria. Thermodynamic study of processes involving phase equilibria. 4 lectures/problem-solving. Prerequisite: 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 lectures/problem-solving. Prerequisites: CHE 303 and CHE 312.

CHE 310L Chemical Engineering Computer Applications Laboratory (1)

Introduction to software applications and the numerical solution of chemical engineering problems. Programming concepts. 1 three-hour computational laboratory. Prerequisites: CHE 202/212L; CHE 132/142L or equivalent.

CHE 311 Momentum Transport (4)

Basic course in fluid mechanics with emphasis on Newtonian 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 calculations 4 lectures/problem-solving. Prerequisites: ME 214, MAT 214, CHE 202.

CHE 312 Energy Transport (3)

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 lectures/problem-solving. Prerequisites: CHE 302 and CHE 311.

CHE 313 Mass Transport (3)

Mass transfer and its application to the unit operations of chemical engineering, including topics in molecular diffusion, convective diffusion, and process design of distillation and absorption towers. Application of mass transfer principles to biological and bioenvironmental systems. 3 lectures/problem-solving. Prerequisites: CHE 312 and CHE 303

CHE 322L Transport Laboratory I (1)

Applying experimental design and the basic concepts in transport phenomena and thermodynamics in experimental study of systems that may involve pressure drop in pipes, flow measurement, viscosity measurement, heat of combustion measurement, energy and entropy balance, pump operating characteristics and measurement of transport properties of both chemical and materials engineering systems. 1 three-hour laboratory. Prerequisites: CHE 202/212L,

CHE 333L Transport Laboratory II (1)

Applying experimental design and the basic concepts in transport phenomena in experimental study of both chemical and materials engineering systems that may involve diffusivity measurement, batch distillation, heat exchanger, membrane separation, droplet evaporation, heat transfer in extended surfaces and others. 1 three-hour laboratory. Prerequisites: CHE 311/322L, CHE 302.

CHE 400 Special Study 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.

CHE 425 Unit Operations I (3)

Treatment of mass, momentum and heat transport viewed with the traditional unit operations emphasis. Multi-component and multiphase systems are considered, with some problems involving design. Distillation, absorption and heat exchanger design. 4 lectures/problem-solving. Prerequisites: CHE 313, CHE 304.

CHE 426 Process Controls (3)

Introduction to theory, design, and application of automatic control systems to chemical and physical processes. 2 lectures/problem-solving. Prerequisites: CHE 304, CHE 312.

CHE 432 Pollution Abatement and Hazardous Materials Management (2)

Improve the understanding of natural processes and the fundamentals that govern the concentrations of contaminants in water, air, and other media. Topics in air pollution, water pollution, and solid waste. Group project involving study and preliminary design, including cost analysis. 2 lectures/problem-solving. Prerequisites: CHE 302, CHE 311.

CHE 435L Unit Operations I Laboratory (1)

Applying the basic concepts in kinetics, thermodynamics, and transport phenomena in experimental study of systems that may involve binary distillation, batch reactor, column operating characteristics, fluidized bed, and others. 1 three-hour laboratory. Prerequisites: CHE 304, CHE 313.

CHE 436L Process Controls Laboratory (1)

Experimental study of the dynamics and control of chemical engineering processes using single-loop, PID controllers. Simulation of real control systems. Hardware requirements for real control systems. 1 three-hour laboratory. Corequisite: CHE 426.

CHE 441/451L Chemical Process Synthesis and Design I/Laboratory (4/1)

Design of major equipment and control systems common to most chemical industries. Emphasis on how equipment fits together and interacts in an integrated process. Optimization strategies in process design. Topics in air pollution, water pollution, and solid waste. Use of

process simulators. 4 lectures/problem-solving and 1 three-hour computational laboratory. Prerequisites: CHE 304, CHE 313.

CHE 442/452L Chemical Processes Synthesis and Design II/Laboratory (3/1)

Treatment of process design methodology. Energy integration in plant design. On-site study of selected process industries. Design problems related to process industries visited. Basic engineering economics including cost estimating. Discussion of contemporary economic issues. Emphasis on use of process simulators. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: CHE 441/451L.

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

Team project to perform process design and cost estimating of a complete plant with attention to environmental constraints including state and Federal laws. Emphasis on team effort, effective communication, plant design procedure, plant management and control. Use of process simulators. 3 lectures/problem-solving and 1 three-hour computational laboratory. Prerequisites: CHE 442/452L.

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

Formal encounter with a professional assignment, simulating the graduate chemical or materials engineer at work and culminating in a final engineering report. Emphasis will be placed on engineering design. Prerequisites: GPAs (major and overall) at least 2.0.

CHE 463 Undergraduate Project (2)

Final state of major project work. Emphasis on effective communication of project results. 2 seminars. Prerequisites: EGR 481 and EGR 482.

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. Instruction is by lecture, laboratory, or a combination. Prerequisites: CHE 302 and CHE 311.

MATERIALS ENGINEERING 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.

MTE 205L Materials Engineering in Industry (1)

Exploration of the role of materials engineering in manufacturing industries. Plant trips to study the processes in the materials conversion industry. Study of the methodology for production, cost reduction, quality, reproducibility, inventory control, and management. 1 three-hour laboratory. Prerequisites: CHM 122/122L.

MTE 207 Materials Science and Engineering (3)

Introduction to the fundamentals and applications of materials engineering. Atomic, molecular, and crystalline structures and properties of materials with their relevance to engineering. Topics will include: diffusion, defects, phase diagrams, heat treatment, mechanical behavior, and will cover the different materials classes, i.e., metals, ceramics, polymers, composites, and semiconductors. 3 lectures/problem-solving. Prerequisites: CHM 121/121L, PHY 131/131L and MAT 116.

MTE 208 Introduction to Electronic Materials and Properties (3)

Introduction to the concepts of bonding, structure, and defects as applied to the materials used in electrical engineering. Band theory as it applies to conductors, semiconductors, and insulators, conduction mechanisms. Electronic devices and methods of fabrication. Fundamentals of dielectric, optical and magnetic materials. Review of relevant mathematical concepts as it applies to understanding and solving problems. 3 lecture/problem-solving. Prerequisites: CHM 121/121L, PHY 133/133L, and MAT 116.

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

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. Instruction is by lecture, laboratory or a combination.

MTE 303/L Polymer Engineering/Laboratory (3/1)

Introduction to the structure, properties, behavior, characterization and processing of polymers as engineering materials. Design of reinforced and unreinforced polymers, and the processing methods used in the manufacture of products. Labs will include polymer testing and plant trips. 3 lectures/problem-solving, and 1 three-hour laboratory. Prerequisites: MTE 207 or ME 315; and MTE 317L or ME 350L; and CHE 311 or ME 311.

MTE 317L Materials Science and Engineering Laboratory (1)

Hands-on experiences to reinforce fundamental materials engineering concepts. Crystal models, microscopy, hardness tests, brittle fracture, strengthening, and heat treatment. Materials selection and design. Emphasis on written and oral technical communication skills. Safety awareness reinforced throughout the course. Elements of statistics and experimental design. 1 three-hour laboratory. Prerequisite: MTE 207 (or ME 315).

MTE 320/L Mechanical Metallurgy/Laboratory (3/1)

A comprehensive exploration of the field of mechanical metallurgy. Topics include the continuum description of stress and strain, the flow and fracture of metals from the defect mechanism point of view, the tests used for determining mechanical properties, and the fundamental/analytical techniques applied to the various metalworking processes used in industry. Labs will include demonstrations, plant trips, and problem solving. Relevant mathematical topics will be reviewed, 3 lectures/problem-solving, and 1 three-hour laboratory. Prerequisites: MTE 207 (or ME 315); and MTE 317L (or ME 350L).

MTE 327/L Properties of Materials/Laboratory (3/1)

A comprehensive exploration of electronic, thermal, magnetic and optical properties of materials. Relationships between structure and properties will be emphasized. The influence of processing on properties and subsequent applications will be highlighted. Labs will include development of experiments, and problem solving. 3 lectures and 1 three-hour laboratory. Prerequisites: MTE 207, MTE 317L, PHY 133/133L.

MTE 328 Thermodynamics of Solids (3)

Macroscopic thermodynamics, the study of energy and its transformations as it applies to the field of materials. First and second law, property relationships, equilibrium, electrochemistry, solutions and mixing, phase rule and phase diagrams. Introduction to statistical thermodynamics will be included as it applies to the understanding of the macroscopic properties and behavior of materials. 3 lectures/problem-solving. Prerequisite: MTE 207 (or ME 315).

MTE 337/L Joining of Materials/Laboratory (2/1)

Introduction to the principles, methods and applications of joining as

they apply to the metals, ceramics, plastics, and electronic industries. Included are fasteners, welding, brazing, soldering, adhesives, diffusion and ultrasonic bonding. Principles of mechanical, chemical, and physical phenomena related to surfaces and the mechanics of joints. The approach will be to unify the principles underlying diverse engineering technologies to the basic science of the joining processes. 2 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: MTE 207 (or ME 315); and MTE 317L (or ME 350L).

MTE 338 Kinetic Processes in Materials (3)

Physical chemistry applied to materials engineering. Topics include: surfaces and interfaces; nucleation and growth theory; diffusional and non-diffusional transformations; precipitation from the solid solution, reaction kinetics, and introduction to non-equilibrium thermodynamics. 3 lectures/problem-solving. Prerequisites: MTE 207 or ME 315; CHE 302 or ME 301.

MTE 400 Special Study 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: ENG 104 or equivalent.

MTE 401/401L Corrosion and Materials Degradation (3/1)

Fundamental principles of corrosion science, application of these principles to corrosion engineering problems and materials selection. Topics to be covered include: Thermodynamics and kinetics of metallic corrosion; corrosive/destructive environments; the different forms of corrosion and degradation, corrosion/degradation prevention; principles of materials selection. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: CHE 303 or ME 302; MTE 207 or ME 315.

MTE 404 Electronic Materials(4)

Advanced concepts of electronic materials and their engineering applications. Free electron model, introduction to band theory, and Schrodinger wave equation, crystal bonding and lattice vibrations. Introduction to processing and materials selection for electronic applications. 4 lectures/problem-solving. Prerequisites: MTE 327 or ME 315; CHE 302 or ME 301.

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 lectures/problem-solving. Prerequisites: MTE 207 (or ME 315); CHE 302 (or ME 301).

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, solidification structures, precipitation hardening, and plant trips. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: MTE 207 (or ME 315); CHE 302 (or ME 301).

MTE 407/L Ceramic Materials/Laboratory (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. Laboratory experiments related to fabrication, testing, statistical analysis, and plant trips. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: MTE 207 and MTE 317L (or ME 315 and ME 350L).

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. Laboratory experiments related to composite fabrication, characterization, testing, and plant trips. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: MTE 207 and MTE 317L (or ME 315 and ME 350L).

MTE 420/L Materials Selection and Design I/Laboratory (2/1)

Integration of the undergraduate courses in the basic sciences, engineering sciences, materials engineering, economics, business, and general education in the integrated solution of materials selection and design problems. Analysis, selection, and evaluation of materials and processes aimed at product development. Use of numeric based selection criteria will be emphasized culminating in professional reports and presentations. 2 lecture discussions, and 1 three-hour laboratory/ problem-solving. Prerequisites: senior standing, GWT, and MTE 338.

MTE 421 Materials Characterization and Testing (4)

Overview of materials characterization and testing methods. Topics include: fundamentals of crystallography, properties of X-rays and X-ray diffraction, determination of crystal structures, IR spectroscopy, electron microscopy, ultrasound evaluation techniques. 4 lectures/problem-solving. Prerequisites: MTE 327 or ME 315.

MTE 422 Fracture and Failure Analysis (4)

Basic principles of fracture mechanics, and applications to failure analysis. Topics include: elements of fracture mechanics, ductile and brittle fracture, residual stresses, creep, fatigue, environmental effects, statistical distributions, and design issues. The approach will emphasize case histories (including guest lectures from practicing engineers on actual studies) and student presentations. Topics include: 4 lectures/problem-solving. Prerequisites: MTE 207 (or ME 315); and MTE 317L (or ME 350L).

MTE 430/L Materials Selection and Design II/Laboratory (2/1)

Integrated approach to materials selection and design utilizing engineering sciences, materials engineering, economics, business and general education. Analysis, selection, and evaluation of materials and processes in design. Use of numeric-based selection criteria emphasized, culminating in professional reports and presentations. 2 lecture discussions, and 1 three-hour laboratory/problem. Prerequisites: MTE 420/L.

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. Instruction is by lecture, laboratory, or a combination.

CIVIL ENGINEERING

www.csupomona.edu/~ce/

Francelina A. Neto, Interim Chair

Dragos Andrei
Wen Cheng
Hany J. Farran
Mikhail Gershfeld
Xudong Jia
William Kitch
Allan Ng
Monica Palomo
Felipe Perez
Abdul Rashidi
Seema Shah-Fairbank
Howard Turner
Yunxia Lisa Wang
Man-chu Ronald Yeung

The program in Civil Engineering prepares graduates to enter the profession in planning, design, construction, operations, 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 subplans: the general civil engineering subplan; the environmental engineering subplan; and the geospatial engineering subplan.

The general civil engineering, geospatial engineering, and environmental engineering subplans are accredited by the Engineering Accreditation Commission of ABET under the civil engineering criteria, http://www.abet.org. The geospatial engineering subplan is also accredited by the Engineering Accreditation Commission of ABET under the surveying engineering criteria, http://www.abet.org.

All subplans provide broad background in the various aspects of the civil engineering profession. The environmental engineering subplan emphasizes solving water resources and environmental pollution problems. The geospatial engineering subplan provides students with a background in the surveying profession.

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, by engineering contractors, and by private consulting firms. 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.

Vision Statement

Provide the best civil engineering learning experience.

Mission Statement

To meet the challenges of an evolving society, we provide practice-oriented civil engineering education that fosters personal, professional, and social responsibility; technical excellence and creativity; and effective communication, teamwork and leadership.

BSCE Program Educational Objectives

Our graduates will be practicing professionals who:

1. Demonstrate a high level of individual, professional and social responsibility.
2. Apply technical and non-technical skills in both traditional and creative ways.
3. Demonstrate strong communication, teamwork and leadership skills.

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

REQUIRED CORE COURSES

Required of all students. A 2.0 cumulative GPA is required in core courses including subplan courses for the major in order to receive a degree in the major.

Civil Engineering CAD I	CE	127/L	(1/1)
Civil Engineering CAD II	CE	128L	(1)
Elementary Surveying	CE	134/L	(2/2)
Structural Analysis I	CE	304	(4)
Structural Analysis II	CE	305	(4)
Structural Testing Laboratory	CE	306L	(1)
Geotechnical Engineering I	CE	325	(2)
Geotechnical Engineering II	CE	326	(3)
Geotechnical Engineering Laboratory	CE	327L	(1)
Hydraulic Engineering	CE	332/L	(3/1)
Technical Communications and Documentation	CE	362/A	(2/1)
Structural Design--Reinforced Concrete	CE	421	(4)
Concrete Testing Laboratory	CE	422L	(1)
Water Supply Engineering	CE	431/L	(3/1)
Engineering Hydrology	CE	451	(4)
Analytic Geometry and Calculus II	MAT	115	(4)
Analytic Geometry and Calculus III	MAT	116	(4)
Calculus of Several Variables I	MAT	214	(3)
Elem. Linear Algebra & Differential Equations	MAT	224	(4)
Vector Statics	ME	214	(3)
Vector Dynamics	ME	215	(4)
Strength of Materials I	ME	218	(3)
Fluid Mechanics I	ME	311	(3)

GENERAL CIVIL ENGINEERING REQUIRED SUBPLAN/OPTION CORE COURSES

Introduction to Civil Engineering	CE	122	(1)
Advanced Surveying	CE	220/L	(3/1)
Highway Engineering	CE	222/L	(3/1)
Transportation Engineering	CE	223/L	(3/1)
Engineering Economics	CE	301	(4)
Computer Programming and Numerical Methods	CE	303/A	(2/1)
Structural Design--Steel	CE	406	(4)
Structural Design--Timber	CE	433/L	(2/1)
Comprehensive Civil Engineering Design I, II, III	CE	491, 492, 493	(4)

GENERAL CIVIL ENGINEERING ELECTIVE SUBPLAN/OPTION SUPPORT COURSES

Upper Division Civil Engineering Courses approved in advance by advisor.

Technical Electives in Civil Engineering	CE	XXX	(11)

ENVIRONMENTAL ENGINEERING REQUIRED SUBPLAN/OPTION CORE COURSES

Introduction to Civil Engineering	CE	122	(1)
Engineering Economics	CE	301	(4)
Computer Programming and Numerical Methods	CE	303/A	(2/1)
Environmental Resource Management	CE	351/L	(3/1)

Structural Design--Steel	CE	406	(4)
Water Quality Engineering	CE	432/L	(3/1)
Industrial and Hazardous Waste Management	CE	434/L	(3/1)
Groundwater Transport	CE	456/L	(3/1)
Solid Waste Management	CE	457	(3)
Comprehensive Civil Engineering Design I, II, III	CE	491, 492, 493	(4)
Thermodynamics I	ME	301	(4)

ENVIRONMENTAL ENGINEERING ELECTIVE SUBPLAN/OPTION SUPPORT COURSES

Upper Division Civil Engineering Courses approved in advance by advisor.

Technical Electives in Civil Engineering	CE	XXX	(3)

GEOSPATIAL ENGINEERING REQUIRED SUBPLAN/OPTION CORE COURSES

Advanced Surveying	CE	220/L	(3/1)
Highway Engineering	CE	222/L	(3/1)
Surveying Computations	CE	240	(3)
Geodesy and Satellite Surveying	CE	311/L	(3/1)
Land Survey Descriptions	CE	313	(4)
Public Land Surveys	CE	331	(3)
Digital Mapping	CE	420/L	(3/1)
Photogrammetry and Remote Sensing	CE	427/L	(3/1)
Subdivision Design	CE	482/L	(3/1)
Geographical Information Systems	CE	484/L	(3/1)
Comprehensive Civil Engineering Design I, II, III	CE	491, 492, 493	(4)

REQUIRED SUPPORT COURSES

The following major support courses should be used to satisfy the indicated GE requirements. If these courses are not used to satisfy GE, the total units to degree may be more than 198 units.

General Chemistry	CHM	121	(3)
General Chemistry Lab (B3)	CHM	121L	(1)
General Chemistry	CHM	122/L	(4)
Ethical Considerations (C4)	EGR	402	(4)
Role of Design Professionals in Society (D4) (for General and Environmental subplans)	EGR	445	(4)
or California Land and Boundaries Law (D4) (for Geospatial subplan)	EGR	322	(4)
Engineering Geology (B5)	GSC	321/L	(4)
Application of Statistics	IME	301	(3)
or Statistical Methods	STA	309	(3)
Analytic Geometry and Calculus I (B4)	MAT	114	(4)
General Physics (B1,B3)	PHY	131/L	(4)
General Physics	PHY	132/L	(4)
General Physics	PHY	133/L	(4)

GENERAL EDUCATION REQUIREMENTS

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

Area A (12 units)

1. Oral Communication
2. Written Communication
3. Critical Thinking

Area B (16 units)

1. Physical Science
2. Biological Science
3. Laboratory Activity
4. Mathematics/Quantitative Reasoning
5. Science and Technology Synthesis

Area C (16 units)

1. Visual and Performing Arts
2. Philosophy and Civilization
3. Literature and Foreign Language
4. Humanities Synthesis

Area D (20 units)

1. U.S. History, Constitution, and American Ideals
2. History, Economics, and Political Science
3. Sociology, Anthropology, Ethnic, and Gender Studies
4. Social Science Synthesis

Area E (4 units)

Lifelong Understanding and Self-development

COURSE DESCRIPTIONS

Lecture and laboratory courses listed together are to be taken concurrently. MPT refers to a passing grade on the Microcomputer Proficiency Test. All CE courses are open only to BSCE and MSCE majors, unless otherwise specified.

CE 110/L Compuers in Civil Engineering (1/1)

Introduction to basics of computers. Application and use of computers in civil engineering. Software to be covered includes Word, Powerpoint, Excel, Project, HTML, and Access. Programming in appropriate language. 1 lecture/problem solving. 1 three-hour laboratory.

CE 122 Introduction to Civil Engineering (1)

Fundamental concepts of civil engineering. The technical, professional, ethical, and social responsibilities of the civil engineer. 1 lecture/problem-solving.

CE 127/L Civil Engineering CAD I/Laboratory (1/1)

Introduction to CAD engines in civil engineering using MicroStation. Primary, combined and complex elements. CAD engine deliverables. Complex shapes and libraries. Shading and multiple mapping. Group functions and customization. Product fee required. 1 lecture-discussion; 1 three-hour laboratory. Prerequisites: MPT or CE 110/L or CIS 101, and C- or better in MAT 105.

CE 128L Civil Engineering CAD II Laboratory (1)

CAD engines in civil engineering using AutoCAD. Primary, combined and complex elements in AutoCAD. Sectional drawings and basic 3-D. Product fee required. 1 three-hour laboratory. Prerequisite: CE 127/127L.

CE 134/L 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. Fundamentals of construction layouts. 2 lecture discussions, 2 three-hour laboratories. Prerequisite: BSCE, MSCE, or BSCET major. Corequisites: CE 128 or ETC 130/L, and MAT 114 or MAT 130.

CE 220/L 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: CE 134/L.

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

Geometric design of highways; roadway structural section; flexible pavement design; rigid pavement design; highway surface treatments

and stabilization. Product fee required. 2 lectures/problem-solving, 2 three-hour laboratories. Prerequisite: CE 220/L.

CE 223/L 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: CE 222/L.

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 computers in surveying. 3 lectures/problem-solving. Prerequisites: CE 220, C- or better in MAT 216 or MAT 224, and MPT or CE 110/110L or CIS 101.

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. Instruction is by lecture, laboratory, or a combination.

CE 301 Engineering Economics (4)

Foundation of engineering economics. Effect of time and interest on money in various combinations: Nominal and effective interest rates, present worth analysis, annual worth analysis, rate of return analysis and cost/benefit analysis. 4 lectures/problem-solving. Prerequisite: completion of Area A GE requirements.

CE 303/A Computer Programming and Numerical Methods/Activity (2/1)

Computer programming in an object-oriented programming language; numerical and statistical methods as applied to civil engineering. 2 lectures/problem-solving and 1 two-hour activity. Prerequisites: C- or better in MAT 216 or MAT 224, and MPT or CE 110/110L or CIS 101.

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 lectures/problem-solving. Prerequisites: C- or better in ME 218, and C- or better in MAT 216 or MAT 224.

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 lectures/problem-solving. Prerequisite: C- or better in CE 304.

CE 306L Structural Testing Laboratory (1)

Load and deflection testing of civil engineering prototype structures, beams, frames, arches, and trusses with the objective of enhancing structural analysis principles learned in CE 304 and CE 305. Use of shake table for undergraduate students to learn the fundamental principles of structural dynamics and earthquake engineering. 1 three-hour laboratory. Prerequisite: CE 305.

E 311/L Geodesy and Satellite Surveying/Laboratory (3/1)

Spherical trigonometry; Cartesian and curvilinear coordinates; transformations; geodetic datums; geodetic position computation; major control network extension; satellite and terrestrial positioning system. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: CE 134/134L, and CE 240 or CE 303/303A.

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 lectures/problem-solving. Prerequisite: CE 134/134L.

CE 314/L Elements of Spatial Positioning/Laboratory (3/1)

History and evolution of scientific methods and technology of positioning. Scientific concepts and positioning techniques as applied to geology, geography, archaeology, agriculture, oceanography and other disciplines. Surveying equipment, elementary field measurements and data collection. Use and integration of photogrammetry, remote sensing, Global Positioning Systems (GPS) and 3D modeling in mapping, observation and study of natural events. 3 lectures/problem solving and 1 three-hour laboratory. Not open to Civil Engineering majors.

CE 325 Geotechnical Engineering I (2)

Introduction to geotechnical engineering. Soil and rock as engineering materials, soil classification, compacted fill, groundwater, geoenvironmental engineering. 2 lectures/problem-solving. Prerequisites: C- or better in ME 218, and C- or better in MAT 216 or MAT 224.

CE 326 Geotechnical Engineering II (3)

Stresses in soil, consolidation and settlement, soil strength, stability of earth slopes, structural foundations, soil improvement. 3 lectures/problem-solving. Prerequisite: CE 325.

CE 327L Geotechnical Engineering Laboratory (1)

Application of geotechnical engineering principles to a design project; use of standard soil mechanics laboratory tests. Written and oral presentation of completed project. 1 three-hour laboratory. Prerequisite: CE 326.

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. 3 lectures/problem-solving. Prerequisite: CE 134/134L.

CE 332/L 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. Use proprietary software to analyze and design water network and stormdrain system. 3 lectures/problem-solving. 1 three-hour laboratory. Prerequisites: ME 311 and C- or better in MAT 216 or MAT 224.

CE 351/L 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, energy topics and noise and air pollution. Labs emphasize practicing techniques and principles studies in lecture and field trips. Product fee required for CE 351. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: MPT or CE 110/110L or CIS 101, and CHM 122/122L.

CE 362/A Technical Communications and Documentation/Activity (2/1)

Study and preparation of documents written by the practicing civil engineer. Oral presentations. Proposals, specifications, environmental impact reports, technical journalism, test reports, research and development reports, design reports. 2 lectures/problem-solving, 1 two-hour activity. Prerequisites: completion of Area A GE requirements, and MPT or CE 110/110L or CIS 101.

CE 400 Special Study 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 406 Structural Design--Steel (4)

Theory and design of structural steel tension members, compression members, beams, beam-columns, and simple connections. Design philosophies. Coverage of the American Institute of Steel Construction Load and Resistance Factor Design (LRFD) specification. 4 lectures/problem-solving. Prerequisite: CE 305.

CE 420/L Digital Mapping/Laboratory (3/1)

Robotic and reflectorless total stations and data collectors; electronic data transfer and interfacing. Laser scanning. Solid and surface modeling tools and theory. Visualization and animation. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: CE 134/134L.

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 lectures/problem-solving. Prerequisite: CE 305.

CE 422L Concrete Testing Laboratory (1)

Composition, proportioning, and testing of concrete mixes. Testing of model reinforced concrete beams. Nondestructive testing of concrete elements for strength, presence of voids and cracks, amount of concrete cover, and size and location of reinforcing bars. 1 three-hour laboratory. Prerequisites: BSCE, MSCE, or BSCET major, and C- or better in ME 218.

CE 424 Foundation and Retaining Wall Design (4)

Analysis and design of structural foundations and retaining walls considering both geotechnical and structural aspects. Topics include spread footings and cantilever walls. 4 lectures/problem-solving. Prerequisite: CE 326. Corequisite: CE 421.

CE 427/L Photogrammetry and Remote Sensing/Laboratory (3/1)

Interpretation of aerial photographs. Stereoscopy. Close range photogrammetry. Application of aerial surveying to engineering problems, mapping. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: CE 134/134L, and CE 240 or CE 303/303A.

CE 428/L Urban Transportation (3/1)

Study and design of transportation in the urban environment, primarily transit; includes history, nature of problems, alternative solutions, costs of modernization, mass transit trends, the subsidy debate, role of the State and Federal governments, rideshare planning, ADA services, financial plans, the nature and importance of planning and transit planning process. 3 one-hour lecture-discussion; 1 three-hour laboratory. Prerequisite: CE 223/223L.

CE 429/L 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: CE 222/222L.

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

Water pollutants and unit process treatment, water quality, water uses, aeration, sedimentation, coagulation, flocculation, filtration, disinfection, and saline water conversion. Product fee required. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: CE 332/332L, CHM 122/122L.

CE 432/L 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, and anaerobic digestion. Major wastewater treatment plant design project. Product fee required. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: CE 431/431L.

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

Design load requirements. Seismic analysis. Fire resistant 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: CE 304.

CE 434/L 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: CE 431/431L.

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

Advanced analysis of 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 lectures/problem-solving, one 3-hour laboratory. Prerequisite: CE 326.

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. Applications of code provisions to the design of columns and shear walls. 4 lectures/problem-solving. Prerequisite: CE 421.

CE 445 Earthquake Engineering (4)

Modes of vibration, structural response, observed behavior, and preventive design measures. Implementation of California Building Code and Structural Engineers Association of California requirements. 4 lectures/problem-solving. Prerequisite: CE 406 or CE 421.

CE 451 Engineering Hydrology (4)

Precipitation, weather modification, evaporation, infiltration, hydrographs, probability concepts, river and reservoir routing, and storm drain design. 4 lectures/problem-solving. Prerequisites: CE 332/332L, and either STA 309 or IME 301.

CE 456/L Groundwater Transport, Contamination & Remediation (3/1)

Darcy's equation, flow equations, well mechanics, source and types of contamination, mass transport equations, advection, dispersion, sorption, numerical modeling, nonaqueous phase liquids, remediation methods. 3 one-hour lecture-discussion; 1 three-hour laboratory. Prerequisites: CE 325 and CE 332/332L.

CE 457 Solid Waste Management (3)

Elements include waste generation, storage, collection, transfer, transport, processing, recovery, and disposal of municipal solid waste. 3 lectures/problem-solving. Prerequisites: CE 351, MPT or CE 110/110L or CIS 101.

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 lectures/problem-solving. Prerequisite: CE 406 or CE 421.

CE 480/L Advanced Highway Design/Laboratory (3/1)

Advanced study of highway and street design, including geometry, drainage, soils, materials, and other topics. Includes development of design drawings using CADD design packages. 3 one-hour lecture-discussions; 1 three-hour laboratory. Prerequisite: CE 222/222L.

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

Engineering and surveying methods in land use planning, design, and construction of subdivision development projects. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: CE 222/222L and CE 332/332L.

CE 484/L 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: CE 134/134L.

CE 488 Computer Methods of Structural Analysis (4)

Development of the flexibility and stiffness methods of structural analysis for trusses, beams, and frames, with emphasis on the stiffness method. Extension of the stiffness method to determine frequencies and mode shapes for use in the Uniform Building Code's dynamic lateral force procedure. Use of a commercially-developed analysis program. 4 lectures/problem-solving. Prerequisite: CE 305.

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

Completion of a comprehensive design project that encompasses multiple disciplines within civil engineering. Projects are performed in student groups working under faculty supervision. 1 or 2 one-hour seminars. Prerequisites for CE 491: CE 223/223L, CE 301, CE 305, CE 332, CE 362, and instructor consent.

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. Instruction is by lecture, laboratory, or a combination.

ELECTRICAL AND COMPUTER ENGINEERING

www.csupomona.edu/~ece

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Toma H. Sacco
Wendy K. Wanderman
Meng-Lai Yin

The Department of Electrical and Computer Engineering (ECE) offers a Bachelor of Science in Electrical Engineering (BSEE), a Bachelor of Science in Computer Engineering (BSCpE), and a Master of Science in Electrical Engineering (MSEE). Graduate students enrolled in the Master of Science in Electrical Engineering (MSEE) program may select from the following options: Communication Systems, Computer Systems, or Control and Robotics Systems. The B. S. in Electrical Engineering (BSEE) and the BS in Computer Engineering (BSCpE) are designed to produce well-educated engineering professionals.

The Electrical Engineering program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. The Computer Engineering program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

Our undergraduate curriculum is designed to provide a well-rounded education encompassing both theory and the practice of engineering. Students are required to take many 'hands-on' laboratories where the practical application of classroom theory is experienced. Additionally, a senior project involving design, implementation, and evaluation is required of all undergraduates and often takes the form of a multi-disciplinary team project. Our undergraduate students are well-prepared upon graduation to begin either a professional career or continue their education in a graduate program.

Graduates from the ECE department are in demand by a broad cross-section of industry, government, public utilities and educational institutions as a result 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 Engineering or Computer Engineering should have a aptitude for science and mathematics, and incoming high school graduates should have taken college preparatory courses in these disciplines. Incoming transfer students should consult an advisor in the ECE department at Cal Poly Pomona to determine which courses meet the program requirements.

Electrical Engineering and Computer Engineering students are encouraged to become active in the student chapter of the Institute of Electrical and Electronics Engineers as well as many other College of Engineering and University student organizations. Qualified students are invited to join the student chapter of Eta Kappa Nu, the national electrical engineering honor society.

ELECTRICAL ENGINEERING

The educational objective of the B.S. in Electrical Engineering (B.S.E.E.) is to prepare students to become successful practitioners of Electrical Engineering. Students are afforded the opportunity to specialize at the junior and senior level by choosing from a number of Specified Programs of Electives (S.P.E.). Some of the S.P.E.'s offered by the department are Power, Electronics including Analog and Digital Devices, Controls and Instrumentation including Robotics and Biomedical, Communications & Signal Processing including Analog and Digital, Digital Systems and Illumination Engineering.

Core Courses for Major

Required of all students. A 2.0 cumulative GPA is required in core courses in order to receive a degree in the major.

Introduction to Electrical Engineering	ECE	109/L	(3/1)
C for Engineers	ECE	114/L	(3/1)
Introduction to Combinational Logic	ECE	204/L	(3/1)
Introduction to Sequential Logic	ECE	205/L	(3/1)
Network Analysis I	ECE	207/L	(3/1)
Network Analysis II	ECE	209/L	(3/1)
Electronic Devices and Circuits	ECE	220/L	(4/1)
Object Oriented Programming	ECE	256	(4)
or Programming for Engineering Applications	ECE	257	(4)
Electromagnetic Fields	ECE	302	(4)
Introduction to Discrete Time Signals & Systems	ECE	306/L	(4/1)
Network Analysis III	ECE	307	(3)
Control Systems Engineering	ECE	309/L	(4/1)
Introduction to Power Engineering	ECE	310/L	(4/1)
Probability, Statistics, and Random Processes	ECE	315	(4)
Linear Active Circuit Design	ECE	320/L	(3/1)
Introduction to Semiconductor Devices	ECE	330	(3)
Introduction to Microcontrollers	ECE	341/L	(3/1)
Communications Systems	ECE	405/L	(4/1)
Professional Topics for Engineers	ECE	464	(1)
Team Project	ECE	467	(1)

ECE Upper Division Electives .....(21)
(12 of the 21 units must be 400 level courses. A minimum of one lab (either 300 or 400 level) is required. If a course has an associated lab, both must be taken.)

Support and Directed Electives

The following major support courses should be used to satisfy the indicated GE requirements. If these courses are not used to satisfy GE, the total units to degree may be more than 198 units.

General Chemistry	CHM	121	(3)
General Chemistry Lab (B3)	CHM	121L	(1)
Project Design and Applications (B5)	EGR	481,482	(2,2)
Analytic Geometry and Calculus I (B4)	MAT	114	(4)
Analytic Geometry and Calculus II	MAT	115	(4)
Analytic Geometry and Calculus III	MAT	116	(4)
Calculus of Several Variables I	MAT	214	(3)
Calculus of Several Variables II	MAT	215	(3)
Elementary Linear Algebra and Differential Equations	MAT	224	(4)
Introduction to Electronic Materials and Properties	MTE	208	(3)
General Physics (B1, B3)	PHY	131/L	(3/1)
General Physics	PHY	132/L	(3/1)
General Physics	PHY	133/L	(3/1)

General Education Requirements

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 your catalog.

Area A (12 units)

1. Oral Communication
2. Written Communication
3. Critical Thinking

Area B (16 units)

1. Physical Science
2. Biological Science
3. Laboratory Activity
4. Math/Quantitative Reasoning
5. Science and Technology Synthesis

Area C (16 units)

1. Visual and Performing Arts
2. Philosophy and Civilization
3. Literature and Foreign Languages
4. Humanities Synthesis

Area D (20 units)

1. U.S. History, Constitution, and American Ideals
2. History, Economics, and Political Science
3. Sociology, Anthropology, Ethnic, and Gender Studies
4. Social Science Synthesis

Area E (4 units)

Lifelong Understanding and Self-development

COMPUTER ENGINEERING

Computer engineers apply the theories and principles of physics and mathematics to the design of hardware, software, networks and processes to solve technical problems. The educational objective of the B.S. in Computer Engineering (B.S.Cp.E.) is to prepare students to become successful practitioners in Computer Engineering. Hardware design engineers design and develop computer hardware, and embedded systems. Software engineers design and develop software systems for control and automation of manufacturing, business and management processes.

Core Courses for Major

Required of all students. A 2.0 cumulative GPA is required in core courses in order to receive a degree in the major.

Introduction to Electrical Engineering	ECE	109/L	(3/1)
C for Engineers	ECE	114/L	(3/1)
Discrete Structures	ECE	130	(4)
Introduction to Combinational Logic	ECE	204/L	(3/1)
Introduction to Sequential Logic	ECE	205/L	(3/1)
Network Analysis I	ECE	207/L	(3/1)
Network Analysis II	ECE	209/L	(3/1)
Electronic Devices and Circuits	ECE	220/L	(4/1)
Object Oriented Programming	ECE	256	(4)
Electromagnetic Fields	ECE	302	(4)
Data Structures for Engineers	ECE	304	(4)
Discrete Time Signals and Systems/Lab	ECE	306/L	(4/1)
Control Systems Engineering	ECE	309/L	(4/1)
Probability, Statistics, and Random Processes	ECE	315	(4)
Electronic Design for Digital Circuits	ECE	325/L	(3/1)
Introduction to Microcontrollers	ECE	341/L	(3/1)
Computer Architecture	ECE	425/L	(3/1)
Operating Systems for Embedded Applications	ECE	426/L	(3/1)
Computer Networks	ECE	431/L	(3/1)
or TCP/IP Internetworking	ECE	433/L	(3/1)
Professional Topics for Engineers	ECE	464	(1)
Team Project III	ECE	467	(1)
Software Engineering	ECE	480	(4)

Elective Core Courses

ECE Upper Division Electives . . . . . (16)

At least 12 of the electives must be satisfied by selecting courses from the following list. The rest of the elective units can be satisfied by selecting courses from the upper division ECE courses. If a course with an associated lab is selected, both must be taken. ECE 342/342L, ECE 343/343L, ECE 404/404L, ECE 408/408L, ECE 414/414L, ECE 415/415L, ECE 423, ECE 423L, ECE 424/424L, ECE 428, ECE 429, ECE 432/432L, ECE 439, ECE 499 (with advisor approval).

Required Support Courses

The following major support courses should be used to satisfy the indicated GE requirements. If these courses are not used to satisfy GE, the total units to degree may be more than 198 units.

General Chemistry	CHM	121	(3)
General Chemistry Lab (B3)	CHM	121L	(1)
Project Design and Applications (B5)	EGR	481,482	(2,2)
Analytic Geometry and Calculus I (B4)	MAT	114	(4)
Analytic Geometry and Calculus II	MAT	115	(4)
Analytic Geometry and Calculus III	MAT	116	(4)
Calculus of Several Variables I	MAT	214	(3)
Calculus of Several Variables II	MAT	215	(3)
Elementary Linear Algebra and Differential Equations	MAT	224	(4)
General Physics (B1, B3)	PHY	131/L	(3/1)
General Physics	PHY	132/L	(3/1)
General Physics	PHY	133/L	(3/1)

General Education Requirements

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 your catalog.

Area A (12 units)

1. Oral Communication
2. Written Communication
3. Critical Thinking

Area B (16 units)

1. Physical Science
2. Biological Science
3. Laboratory Activity
4. Math/Quantitative Reasoning
5. Science and Technology Synthesis

Area C (16 units)

1. Visual and Performing Arts
2. Philosophy and Civilization
3. Literature and Foreign Languages
4. Humanities Synthesis

Area D (20 units)

1. U.S. History, Constitution, and American Ideals
2. History, Economics, and Political Science
3. Sociology, Anthropology, Ethnic, and Gender Studies
4. Social Science Synthesis

Area E (4 units)

Lifelong Understanding and Self-development

COURSE DESCRIPTIONS

ECE 109 Introduction to Electrical Engineering (3)

Introduction to the fundamental laws of electrical engineering, applications to circuit analysis, matrix methods. Product fee required. 3 lectures/problem-solving. Prerequisite: C or better in MAT 114. Corequisite: ECE 109L.

ECE 109L Introduction to Electrical Engineering Laboratory (1)

Selected laboratory experiments emphasizing the use and operation of electrical test equipment. Product fee required. 1 three-hour laboratory. Prerequisite: C or better in MAT 114. Corequisite: ECE 109.

ECE 114 C for Engineers (3)

Computer programming for ECE. Problem-oriented computer language applications to electrical networks. 3 lectures/problem-solving. Prerequisite: MAT 114. Corequisite: ECE 114L.

ECE 114L Programming Laboratory for Engineers (1)

This laboratory helps students to learn how to apply the ECE 114 course materials with hands-on computer programming exercises and engineering application. Students practice algorithm development, programming style, and debugging techniques in the computer laboratory. 1 three-hour laboratory. Prerequisite: MAT 114. Corequisite: ECE 114.

ECE 130 Discrete Structures (4)

Fundamental topics for computer engineering, including mathematical logic, sets and relations, basic counting rules, functions and recursion, graphs and trees. 4 lectures/problem solving. Prerequisites: ECE 114/L or equivalent.

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, maximum of 2 units per quarter.

ECE 204 Introduction to Combinational Logic (3)

Analysis and design of combinational circuits. Use of HDL to synthesize combinational logic circuits. 3 hours of lecture/problem solving. Prerequisites: ECE 109/L, ECE 114/L, ENG 103 or ENG 104. Corequisite: ECE 204L.

ECE 204L Introduction to Combinational Logic Laboratory(1)

Design, implementation, and testing of combinational circuits. 3 hours laboratory. Prerequisites: ECE 109/L and ECE 114/L. Corequisite: ECE 204.

ECE 205 Introduction to Sequential Logic (3)

Analysis and design of finite state machines with state diagrams and ASM charts. Design of finite state machines with HDL. Implementation of finite state machines with FPGAs. 3 hours lecture/problem solving. Prerequisites: ECE 204/L. Corequisite: ECE 205L.

ECE 205L Introduction to Sequential Logic (1)

Implementation of finite state machines with FPGA's using Verilog. 3 hours laboratory. Prerequisites: ECE 204/204L. Corequisite: ECE 205.

ECE 207 Network Analysis I (3)

An introduction to network analysis in the time domain using differential equations with computer applications. Product fee required. 3 lectures/problem-solving. Prerequisites ECE 109L; MAT 224 or MAT 216; PHY 133, C- or better in ECE 109; ENG 103 or 104.

ECE 207L Network Analysis I Laboratory (1)

Selected laboratory exercises in electrical networks. Product fee required. 1 three-hour laboratory. Prerequisites: ECE 109L, ECE 207, and PHY 133L.

ECE 209 Network Analysis II (3)

An introduction to network analysis in the frequency domain with computer applications. Product fee required. 3 lectures/problem-solving. Prerequisite: C- or better in ECE 207.

ECE 209L Network Analysis II Laboratory (1)

Selected laboratory exercises in electrical networks. Product fee required. 1 three-hour laboratory. Prerequisite: ECE 209, ECE 207L.

ECE 220 Electronic Devices and Circuits (4)

Structure, characteristics, operation and biasing fundamentals of 2 and 3-terminal semiconductor devices, i.e., diodes, FETs and BJTs. Biasing, bias stability, load line methods and use of transfer curves to bias and design simple amplifier and inverter configurations. Introduction to small-signal parameters. Introduction to CMOS. Product fee required. 4 lectures/problem-solving. Prerequisites: C- or better in ECE 207. Prerequisite or corequisite ECE 209.

ECE 220L Electronics Laboratory (1)

Experiments dealing with common types of semiconductor devices: Diodes and applications (rectifier, clipper, clamper); MOSFETs & BJTs. Device characterization, biasing and analysis/design of basic configurations. Product fee required. 1 three-hour laboratory. Prerequisites: C- or better in ECE 220.

ECE 231/231L 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 lectures/problem-solving. 1 three-hour laboratory. Prerequisites: MAT 116, PHY 133.

ECE 256 Object Oriented Programming (4)

Class encapsulation, inheritance, polymorphism, object storage management, and exception handling. Program debugging, software reuse and object-oriented programming. 4 lectures/problem solving. Prerequisite: ECE 114/L.

ECE 257 Programming for Engineering Applications (4)

Introduction to MATLAB and Simulink programming with applications for ECE. Development and debugging of programs using MATLAB and Simulink. Introduction of selected MATLAB toolboxes. 4 lectures/problem-solving. Prerequisites: ECE 109, ECE 114/L.

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. Instruction is by lecture, laboratory or a combination. Prerequisite: or consent of the instructor.

ECE 302 Electromagnetic Fields (4)

Maxwell's equations and electromagnetic concepts. Introduction to static and time varying fields; plane waves, boundary conditions, and transmission line equations. Applications to analog and digital circuits. 4 lectures/problem-solving. Prerequisites: PHY 133, MAT 215, MAT 224 , ECE 204, and ECE 220.

ECE 304 Data Structures for Engineers (4)

Implementation of data structures using C++ programming language. Utilization of data structures such as stacks, linked lists, trees and graphs in solving engineering problems. Use of C++ standard template library (STL) in code development Four lecture/problem solving sessions. Prerequisites: ECE 130, ECE 256, ECE 204/L, and MAT 116.

ECE 306 Discrete Time Signals and Systems (4)

Time and frequency domain analysis of discrete time signals and systems. 4 lecture/problem-solving. Prerequisite: ECE 209.

ECE 306L Discrete Time Signals and Systems Laboratory (1)

Selected experiments and simulations of continuous-time and discrete-time signals and systems using Digital Signal Processing (DSP) board and simulation software packages. Prerequisite: ECE 306.

ECE 307 Network Analysis III (3)

Frequency selective and two-port networks in the complex frequency domain. Fourier series and fourier transforms with applications to circuit analysis. Product fee required. 3 lectures/problem-solving. Prerequisites: ECE 209, ECE 306.

ECE 309 Control Systems Engineering (4)

System modeling and performance specifications. Design and analysis of feedback control system via root locus and frequency response. Compensation techniques. 4 lectures/problem-solving. Prerequisite: ECE 209.

ECE 309L Control Systems Laboratory (1)

Control System design assignments based upon the course work of ECE 309. Verification of design solutions through digital simulations. 1 three-hour laboratory. Prerequisite: ECE 309.

ECE 310 Introduction to Power and Electric Drive Systems (4)

Basic principles of power engineering with emphasis on magnetics, transformers, rotating AC and DC machines and an introduction to switch-mode power converters in electric drives. Magnetic fields and circuits, as they apply to power transformers and AC and DC machines. Steady-state operational models of electrical machines and transformers, basic feedback control for motor drives, and an introduction to space vectors in AC machine analysis and control. 4 lectures/problem-solving. Prerequisite: ECE 209.

ECE 310L Power Engineering Laboratory (1)

Selected experiments in power engineering including three phase circuits, magnetics, transformers, AC and DC machines. 1 three-hour laboratory. Prerequisite or Corequisite: ECE 310.

ECE 315 Probability, Statistics, and Random Processes for Electrical and Computer Engineering (4)

Concept of probability, statistics, random variables, and random processes. Analysis of random signals through linear time invariant systems. 4 lectures/problem-solving. Prerequisites: MAT 215 and ECE 306.

ECE 317 Advanced Electric Drives (3)

Space vector analysis of asynchronous (induction) and synchronous AC machines. Vector and torque control strategies using pulse-width modulated inverters. 3 lectures/problem-solving. Prerequisite: ECE 310.

ECE 317L Advanced Electric Drives Laboratory (1)

Selected experiments are performed to demonstrate the principles and characteristics of advanced electric drives for AC and DC machines. 1 three-hour laboratory. Prerequisite or corequisite: ECE 317.

ECE 318 Electrical Machines (3)

AC machine analysis with an emphasis on the steady state and dynamic operation of synchronous generators with application to power utilities. 3 lectures/problem-solving. Prerequisite: ECE 310.

ECE 318L Electrical Machines Laboratory (1)

Experiments on the steady state operation and analysis of AC machines. 1 three-hour laboratory. Prerequisite or corequisite: ECE 318.

ECE 320 Linear Active Circuit Design (3)

Small-signal modeling and design of single stage FET and BJT amplifiers using device properties and appropriate device models. Included are gain and input/output impedances; multistage amplifiers; frequency response of AC coupled single-stage amplifier, low and high frequency roll-offs; DC coupled multistage amplifiers. Use of active-load and CMOS for IC aplifiers. Product fee required. 3 lectures/problem-solving. Prerequisites: ECE 209 and C- or better in ECE 220.

ECE 320L Basic Active Circuit Laboratory (1)

Design and evaluation of basic FET and BJT amplifier circuits, both single and multistage. Evaluate DC and AC performance. Product fee required. 1 three-hour laboratory. Prerequisites: ECE 220L, C- or better in ECE 320.

ECE 322 Operational Amplifiers and Electronic Feedback (4)

2-port networks; amplifier models; feedback topologies and their use in circuit design; non-ideal operational amplifier models and their applications to circuit design; frequency response, stability, and frequency compensation; oscillators; noise models and the effect of noise on feedback performance. 4 lectures/problem solving. Prerequisite: ECE 320.

ECE 322L Operational Amplifiers and Electronic Feedback Lab (1)

Design and evaluation of feedback, operational amplifier, oscillator, and signal conditioning circuits. 1 three-hour laboratory. Prerequisite: ECE 320L. Prerequisite or corequisite: ECE 322.

ECE 323 Instrumentation Systems (3)

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 lectures/problem-solving. Prerequisites: ECE 220/220L or ECE 231. Corequisite: ECE 323L.

ECE 323L Instrumentation Systems Laboratory (1)

Instrumentation system assignments based upon the course work of ECE 323. Verification of design solutions. 1 three-hour laboratory. Corequisite: ECE 323.

ECE 325 Electronic Design of Digital Circuits (3)

Device structures for primary logic families. Analysis of switching characteristics and waveform propagation. Structures of various memory devices, logic arrays. Product fee required. 3 lectures/problem-solving. Prerequisites: ECE 205/L, ECE 220/L. Corequisite: ECE 325L.

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

Laboratory exercises to complement the corequisite lecture course. Product fee required. 1 three-hour laboratory. Prerequisites: ECE 205/L, ECE 220/L. Corequisite: ECE 325.

ECE 330 Introduction to Semiconductor Devices (3)

Fundamentals of semiconductor devices: Characteristics of silicon and other semiconductors. Structure, operation and characteristics of junction diodes, metal-semiconductor diodes, and Field Effect Transistors. Overview of BJT structure and operation. 3 lectures/problem-solving. Recommended preparation: ECE 302. Prerequisites: MTE 208 and ECE 220.

ECE 341 Introduction to Microcontrollers (3)

Microcontroller programming, applications, and interfacing. 3 hours lecture/problem solving. Prerequisites: ECE 205/L and ECE 207. Corequisite: ECE 341L.

ECE 341L Introduction to Microcontrollers Laboratory (1)

Microcontroller applications and interfacing. 3 hours laboratory. Prerequisites: ECE 205/L and ECE 207. Corequisite: ECE 341.

ECE 342 Computer Engineering (4)

Analysis and design of computer engineering systems, based on the Intel 80x86 architecture. Topics include: hardware specifications, peripheral interfacing, interrupts and programming. 4 lectures/problem-solving. Prerequisite: ECE 341/L. Corequisite: ECE 342L.

ECE 342L Computer Engineering Laboratory (1)

Experiments demonstrating analysis and design of computer engineering systems, including computer architecture. 1 three-hour laboratory. Prerequisite: ECE 341/L. Corequisite: ECE 342.

ECE 343 Microprocessor I (4)

Analysis and design of computer engineering systems, including microprocessors. 4 lectures/problem-solving. Prerequisites: ECE 204/L. Corequisite: ECE 343L

ECE 343L Microprocessor I Laboratory (1)

Design and build Motorola 68000-based microcomputer from chip level. 1 three-hour laboratory. Prerequisite: ECE 204/L. Corequisite: ECE 343.

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 402 Fields and Waves in RF Electronics (4)

Electrodynamics, wave equations, and reflection and scattering of waves. Radio frequency applications of transmission line techniques, and impedance matching. S-parameter design techniques. Couplers, hybrids, and filters. Experiments on impedance matching, RF circuits, antennas, and S-parameter measurements using Network Analyzers. 4 lectures/problem-solving. Prerequisite: ECE 302.

ECE 403 Introduction to Filter Design (4)

An introduction to the design of passive and active filters. 4 lectures/problem-solving. Prerequisites: C- or better in MAT 114; ECE 309.

ECE 404 Robotics (3)

Introduction to robotics. Kinematics, position analysis, Denavit-Hartenberg representation, differential motion, dynamic analysis and control. Trajectory planning, actuators, sensors and low-level robotic vision. Artificial intelligence. 3 one-hour lecture/problem solving sessions. Prerequisite: ECE 309.

ECE 404L Robotics Laboratory (1)

Selected experiments on control schemes and performance, including but not limited to servomotor and encoder characteristics, and pulse-width modulator basics. One (1) three-hour laboratory. Prerequisite or corequisite: ECE 404.

ECE 405 Communications Systems (4)

Introduction to communication systems: continuous wave modulation and demodulation. Power efficiency, bandwidth efficiency and system complexity of modulation systems. Performance of communication systems in noise. Sampling process and various types of pulse modulation. 4 lectures/problem-solving. Prerequisites: ECE 307, ECE 315.

ECE 405L Communications Laboratory (1)

To study and implement the basic theory of the design and analysis of communication systems. To learn the operation of laboratory instruments used in modern communication systems. 1 three-hour laboratory. Prerequisite: ECE 405.

ECE 406 Wireless Communication Systems (4)

Design and Performance Analysis of Digital Communication Systems including FSK, BPSK, QPSK, QAM, GMSK. Experiments will include performance evaluation of RF oscillators, mixers, ASK/FSK/BPSK modulators, transmitters, and digital receivers. Pseudo Noise (PN) Codes. PN-coded spread-spectrum BPSK Transmitter and Receiver. System level testing will include Wireless, and Optical Systems. Special Experiments on BER and FDMA/TDMA/CDMA will be conducted depending on the availability of equipment and parts. 4 lectures/problem-solving. Prerequisite: ECE 405. Corequisite: ECE 405L.

ECE 407 CMOS Analog Circuits (4)

Analysis and design of analog circuits implemented using CMOS integrated circuit technology. 4 lectures/problem-solving. Prerequisite: ECE 320.

ECE 408 Digital Signal Processing (3)

The analysis, design and implementation of Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) filters. 3 lectures/problem-solving. Prerequisite: ECE 306.

ECE 408L Digital Signal Processing Laboratory (1)

Implementation of FIR filters, IIR filters, adaptive filters, and fast Fourier transforms on digital signal processing boards. 1 three-hour laboratory. ECE 408, prerequisite or corequisite.

ECE 409 Digital Communication Systems (4)

Introduction to digital communication systems: fundamental limitations of communication systems. Digital baseband transmission techniques. Nyquist intersymbol interface criterion. Matched filter concept. Digital modulation and demodulation techniques. 4 lectures/problem-solving. Prerequisite: ECE 405.

ECE 410 Microwave Systems (4)

Principles of waveguide devices, and active microwave devices. Scattering parameter techniques. Design of microwave circuits and components. Design of receivers, transmitters, and radar systems. Microwave network analysis and system level testing. 4 lectures/problem-solving. Prerequisites: ECE 402.

ECE 410L Microwave Engineering Laboratory (1)

Electronic measurement equipment and techniques for measurements at microwave frequencies of such quantities as power, impedance, standing wave ratio and frequency, S-parameters, and impedance matching. Network analysis. Microwave mixer and oscillator characteristics, and radar system measurements.. 1 three-hour laboratory. Prerequisite: ECE 402. Corequisite: ECE 410.

ECE 412 Integrated Circuits: Devices and Modeling (4)

Theory, modeling and applications of devices used in modern integrated circuits. Emphasis is on field effect devices including MOSFETs, CMOS, gallium arsenide MESFETs, and charge-coupled devices. Four one-hour lectures/problem sessions. Prerequisite: ECE 330.

ECE 414 Digital Control Systems (3)

Analog and digital signal conditioning, z-transformation techniques, modeling of discrete systems, analysis of discrete systems, fuzzy logic controllers, PID controllers, design of digital control systems and implementation of digital control systems. 3 lectures/problem-solving. Prerequisites: ECE 309, ECE 341/341L, and ECE 306/L; Concurrent: ECE 414L.

ECE 414L Digital Control Systems Laboratory (1)

Laboratory work involves applying the analysis and design methods presented in the lecture to selected process control systems using both simulated and actual processes. 1 three-hour laboratory. Corequisite: ECE 414.

ECE 415 Digital Design using Verilog HDL (3)

Review of digital design concepts, design using PLDs, CPLDs and FPGAs, hardware Modeling with Verilog HDL, behavioral descriptions in Verilog, synthesis of combinational circuit, and state machines, language constructs, and design for testability. Three one-hour lectures/problem sessions. Prerequisites: ECE 341/341L. Corequisite: ECE 415L.

ECE 415L Digital Design using Verilog HDL Laboratory (l)

Design, synthesis and testing of combinational logic circuits and state machines using an FPGA. 1 three-hour laboratory. Prerequisites: ECE 341/341L. Corequisite: ECE 415.

ECE 418 Integrated Circuits; Design and Fabrication (4)

Fundamentals of fabrication technologies and physical layout design of digital and analog integrated circuits with an emphasis on CMOS VLSI. Materials and device processing technologies. Introduction to layout design tools and rule checking. 4 lectures/problem-solving. Prerequisites: ECE 320 (or ECE 325) and ECE 330.

ECE 419 Advanced Control Systems (3)

Time-domain and frequency-domain design of control systems; concepts of state and state space; description of dynamic systems in state-variable format; canonical forms; controllability and observability; state feedback and state estimation; applications and hardware. 3 one-hour lecture/problem-solving sessions. Prerequisite: ECE 309. Corequisite: ECE 419L.

ECE 419L Advanced Control Systems Laboratory (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. 1 three-hour laboratory. Prerequisite. ECE 309. Corequisite: ECE 419.

ECE 420 Lasers (4)

Introduction to ray optics, beam optics, diffraction, coherence, and phoronoptics. Fundamental principles and applications of lasers, energy levels and mechanisms of excitation, basic types of lasers. Q switching and modes. Modulation and detection. 4 lectures/problem-solving. Prerequisites: ECE 302.

ECE 421 Power System Analysis I (3)

Advanced methods of analysis of power system, per-unit system, single-line representation of power systems, transmission line design and operation, use of power systems analysis software for the solution of system problems, and power flow. 3 lectures/problem-solving. Prerequisite: ECE 318 or C- or better in ECE 310.

ECE 421L Power System Analysis I Laboratory (1)

Experiments and computer modeling using available software to simulate the characteristics of power transmission systems under various operating conditions. 1 three-hour laboratory. Prerequisite or concurrrent: ECE 421.

ECE 422 Power System Analysis II (3)

Power system stability and fault conditions, specific design considerations, symmetrical and asymmetrical faults, symmetrical components, system protection, and economic operating practices. Use of computer software for fault and stability analysis. 3 lectures/problem-solving. Prerequisite: ECE 421.

ECE 422L Power System Analysis II Laboratory (1)

Experiments and computer modeling to demonstrate fault conditions, instability, and protection methodology in power systems. 1 three-hour laboratory. Prerequisite or concurrent: ECE 422.

ECE 423 Very Large Scale Integrated (VLSI) Circuit Design (4)

Integrated circuit chip design in silicon CMOS technology. Computer aided physical layout design and simulation of Digital Integrated Circuits-Combinational logic and Sequential logic circuits. Static and dynamic operation of logic circuits. Timing issues in digital circuits. The influence of parasitic capacitances, inductances, and resistances on the design performance. Semiconductor memory and Array structures. Chip input and output circuits. Optimizing speed, area, power. 4 lecture /problem-solving. Prerequisite: ECE 320 or ECE 325.

ECE 423L VLSI Design Laboratory (1)

Integrated circuit chip design laboratory. Computer aided physical layout design, simulation and verification of integrated circuits. One 3 hour lab. Prerequisite: ECE 418; or ECE 423 (Corequisite or Prerequisite).

ECE 424 Digital System Design using VHDL (3)

Design of digital systems. VHDL, modeling and simulation of digital systems using VHDL. Implementation of Digital Systems using FPGAs. 3 lectures/problem-solving. Prerequisite: ECE 341. Corequisite: ECE 424L.

ECE 424L Digital System Design Using VHDL Laboratory (1)

VHDL modeling of digital systems. Implementation of digital system using FPGAs. One (1) three-hour laboratory. Prerequisite: ECE 341. Corequisite: ECE 424.

ECE 425 Computer Architecture (3)

RISC architecture, instruction sets, programming, pipelining, and cache memories and the design of a single cycle RISC CPU. 3 lecture/problem-solving. Prerequisites: ECE 341/L and ECE 205/L. Corequisite: ECE 425L.

ECE 425L Computer Architecture Laboratory (1)

RISC architecture, instruction sets, programming, pipelining, and cache memories and the design of a single cycle RISC CPU. 3 hours laboratory. Prerequisites: ECE 341/341L and ECE 205/L. Corequisite: ECE 425.

ECE 426 Operating Systems for Embedded Applications (3)

Operating system concepts including memory, device and file management techniques and design of a real time operating system for embedded controllers. Three lectures/problem-solving. Prerequisites: ECE 256 and ECE 341/341L. Corequisite: ECE 426L.

ECE 426L Operating Systems for Embedded Application Laboratory (1)

Operating system concepts including memory, device and file management techniques and design of a real time operating system for embedded controllers. 1 three- hour laboratory. Prerequisites: ECE 256 and ECE 341/341L. Corequisite: ECE 426.

ECE 428 Digital Signal Processing II (4)

A continuation of digital filter design and an introduction to digital signal processing algorithms. 4 lectures/problem-solving. Prerequisite: ECE 408.

ECE 429 Application Development Using JAVA (4)

Essential object-oriented programming concepts: encapsulation, inheritance and polymorphism, GUI Development, multimedia applications, multi-tasking, network programming using Internet. 4 lectures/problem-solving. Prerequisite: ECE 256

ECE 431 Computer Networks (3)

Guided and unguided media; signals; flow and error control; MAC; networking devices; routing; IEEE standards for LANs, internet, networking of embedded systems. 3 lectures/problem-solving. Prerequisites: ECE 341/L. Corequisite: ECE 431L.

ECE 431L Computer Networks Laboratory (1)

Projects in the areas of data communication and embedded systems networking. Laboratory work involves hardware implementation, software development, testing and simulation. 1 three-hour laboratory. Corequisite: ECE 431.

ECE 432 Microprocessor II (3)

Microcomputer applications at the systems level. Course to include usage of both hardware and software design aids. 3 lectures/problem-solving. Prerequisites: ECE 343/L or ECE 341/L. Corequisite: ECE 432L.

ECE 432L Microprocessor II Laboratory (1)

Design and build Intel Pentium-based microcomputer in real mode from chip level. Design and implementation of typical 32-bit microprocessor applications using the Intel Pentium. 1 three-hour laboratory. Prerequisites: ECE 343/L or ECE 341/L. Corequisite: ECE 432.

ECE 433 TCP/IP Internetworking (3)

Principles, protocols, architecture, coding, and performance analysis of transmission control protocol and Internet protocol. 3 lectures/problem-solving. Prerequisites: ECE 341/L and ECE 256; Corequisite: ECE 433L.

ECE 433L TCP/IP Internetworking Laboratory (1)

Principles, protocols, architecture, codings and performance analysis of transmission control protocol and internet protocol. 1 three-hour laboratory. Prerequisites: ECE 341/341L and ECE 256. Corequisite: ECE 433

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.

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. 3 lectures/problem-solving. Prerequisite: BIO 110, or BIO 115, or BIO 121 or equivalent. Corequisite: ECE 435L.

ECE 435L Biomedical Instrumentation and Measurements Laboratory (1)

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. 1 three-hour laboratory. Prerequisite: BIO 110, or BIO 115, or BIO 121 or equivalent.Corequisite: ECE 435.

ECE 436 Optical Fiber Communications (4)

Introduction to optical fibers. 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. Design specifications, options, tradeoffs and cost. Integrated optics. Laser technology applied to optical communications. New developments. 4 lectures/problem-solving. Prerequisites: ECE 302, ECE 330, ECE 405.

ECE 437 Introduction to Photonics (4)

The nature of light. Simple geometric optics. Thermal and atomic-line light sources, modulation of lights. Nonlinear optics and parametric oscillations. Luminescence. Display devices. Laser and laser light. Photodetectors, optical waveguides. ECE 302 prerequisite, ECE 330 prerequisite, or corequisite.

ECE 439 Embedded System Design and Applications (4)

Program development in various application areas such as mobile

computing, networking database, data structures, multithreading and/or network security. Exposure to different platforms and programming languages. Practicing developing, testing, debugging, and porting in software and firmware. 4 lectures/problem-solving. Prerequisite: ECE 256 or ECE 341.

ECE 448 R.F. Design (4)

Principles of R.F. design of transmitters and receivers utilizing solid state electronics devices and integrated circuits. RF design techniques including S-parameters, design of amplifiers, oscillators, mixers and detectors. 4 lectures/problem-solving. Prerequisite: ECE 402.

ECE 448L R.F. Design Laboratory (1)

Principles of R.F. Design of transmitters and receivers utilizing solid state electronics devices and integrated circuits. Design of oscillator, power amplifiers, mixers and detectors. 3 lectures/problem-solving and 1 three-hour laboratory. ECE 448 and ECE 448L are to be taken concurrently. Prerequisite: ECE 402.

ECE 464 Professional Topics for Engineers (1)

New developments, policies, practices, procedures and ethics in Electrical and Computer Engineering. 1 lecture. Prerequisites: completion of all 100 and 200 level courses, Junior or Senior standing, and satisfactory completion of the Graduate Writing Test (GWT).

ECE 465, 466 and 467 Team Project I, II and III (2), (2), (1)

Completion of a capstone senior design team project under faculty supervision. Project results are presented in a formal report. Minimum 120 hours required. Prerequisites for ECE 465: Senior Standing. Prerequisites for ECE 466: ECE 465. Prerequisites for ECE 467: ECE 465/466 or EGR 481/482 taken within the department or with the department pre-approval.

ECE 468 Power System Electronics (3)

Power electronics applications for industry and power utilities. The emphasis is on the analysis and design of power system components including single and three-phase. DC rectifiers, controlled rectifiers, and DC to AC converters. Selected applications include HV-DC transmission, resonant converters, AC and DC motor drives, static var control, and power quality issues. 3 lectures/problem-solving. Prerequisite: ECE 220.

ECE 468L Power System Electronics Laboratory (1)

Selected experiments in Power Electronics covering single and three-phase DC rectifiers using power diodes and thyristors and utility applications including static var correction, thyristor controlled inductors, etc. 1 three-hour laboratory. Prerequisite or corequisite: ECE 468.

ECE 469 Power Electronics (3)

Basic principles of power electronics with an emphasis on the analysis and design of DC switch-mode power supplies and DC to AC inverters using pulse-width modulation (pwm). Basic circuit topologies, control modes (voltage/current, etc), control stability, high power factor design, pwm amplifiers, design of magnetic components and output filters. 3 lectures/problem-solving. Prerequisites: ECE 220.

ECE 469L Power Electronics Laboratory (1)

Selected experiments to study the basic topologies used in DC to DC switch-mode converters, pulse-width modulated integrated circuits for voltage/current regulation, air-gaps in magnetic circuits, and output filters. 1 three-hour laboratory. Prerequisite or corequisite: ECE 469.

ECE 480 Software Engineering (4)

Software engineering processes including requirements engineering, specification techniques, design concepts and methods, software testing and integration concepts, verification and validation, quality assurance, configuration management, and software documentation. 4 lectures/problem solving. Prerequisites: ECE 304, and ECE 426.

ECE 490 Introduction to Illumination Engineering (4)

An introduction to light as waves and particles, photometric units, color, vision, daylighting, incandescent of luminescent light sources, luminairs and controls. Basic measurements and calculations, basic indoor lighting analysis and design. 4 lectures/problem-solving. Prerequisites: ECE 209 or ECE 231 or PHY 123. Corequisite: ECE 490L.

ECE 490L Illumination Engineering (ILE) Laboratory (1)

This lab is a demo tool and a practical platform for lighting experimentation. Experiments comprise of light sources and systems, photometric and electrical analysis and the practical use of photometric and electrical analytic equipment. Lab experiments verify various physical laws, cover outside measurements, photometry of sources and luminaries, and practical analysis and design of indoor lighting systems. Detailed individual and team reports are required; industrial manufacturing and utilities' lab visits are included and required. 1 three-hour Laboratory. Corequisite: ECE 490.

ECE 492/492L Lighting Control/Design (4/1)

Analysis and design of light control systems, occupancy sensors, and magnetic/electric ballasts. Selected sections of both State and Federal regulations covering lighting systems and ANSI specifications. 4 lectures/problem-solving. 1 three-hour laboratory. Prerequisite: ECE 209 or ECE 231 or PHY 123.

ECE 499/499L 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. Instruction is by lecture, laboratory or a combination.

ENGINEERING TECHNOLOGY

www.csupomona.edu/~et/

Gerald K. Herder, Chair

Hovel Y. Babikian	Norali Pernalete
Fazal B. Kauser	Tariq Qayyum
Massoud Moussavi	Yasser Salem

The Engineering Technology department offers three bachelor of science degrees in engineering technology; Electronics and Computer (ECET), Construction (CET) and Engineering Technology (ET General - Mechanical and Manufacturing). The programs have integrated curricula designed to prepare graduates for technical careers in industry.

In each degree program, emphasis is placed on application engineering principles in solving real world problems. Extensive laboratory work with industry-based problems and software constitute unique features of each program. Engineering technologists serve as members of the engineering team and engage in the management, design, production, assembly, quality control and sales activities in their respective fields.

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 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, and/or provide customer engineering support.

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. Typical incoming transfer students should have completed college algebra and trigonometry and two quarters of college physics (with laboratory) prior to beginning the program at Cal Poly Pomona. 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 198 quarter units is required to complete the degree.

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, computer-aided drafting (CAD), computer usage, oral and written communications, design and manufacturing processes, and the impact of technology within a broader societal context.

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 timeliness; to communicate effectively in written, oral, graphical, and mathematical form; and to be responsible for their own actions and inactions. The faculty is committed to academic excellence and professional integrity.

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

CONSTRUCTION ENGINEERING TECHNOLOGY (CET)

The Construction Engineering Technology Program is accredited by the Technology Accreditation Commission of ABET, http://www.abet.org. This degree provides the student with a firm background in construction practices. Graduates may eventually work in any area of construction including commercial, 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 implement 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), which is associated with 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. Additional information on the CET program can be found on the web at www.csupomona.edu/cet/

ELECTRONICS AND COMPUTER ENGINEERING TECHNOLOGY (ECET)

The Electronics and Computer Engineering Technology program is accredited by the Technology Accreditation Commission of ABET, http://www.abet.org. In today's complex world, electronics, computers, and communications permeate every facet of our lives, and will do even 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.

This 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 analog and digital electronics, computer hardware and software, networks, communications and control electronics. 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. Graduates become members of the engineering team involved in the realization of technical projects. Typical roles are in Systems Engineering positions with an emphasis in product verification (test) and validation (application). www.csupomona.edu/ ecet/

ENGINEERING TECHNOLOGY GENERAL (MECHANICAL/MANUFACTURING)

The Engineering Technology program is accredited by the Technology Accreditation Commission of ABET, http://www.abet.org.

The ET major stresses the application and design of mechanical and thermal power systems utilizing strength of materials, metallurgy, statics, dynamics, fluid mechanics, thermodynamics and heat transfer principles. Graduates may be involved in applied design, analysis, application, or production of mechanical/thermo-fluid systems.

The program also offers courses with a manufacturing emphasis which stresses technological competency and managerial skills in the economical utilization of raw material and resources through planning, selection, and organization of manufacturing processes. Graduates may

be involved in mass production, tooling, selection of machines, and the marketing of manufactured goods. www.csupomona.edu/etg/

Note: A 2.0 GPA is required in core courses to receive a degree in all Engineering Technology majors.

CORE COURSES FOR CONSTRUCTION ENGINEERING TECHNOLOGY (88 units)

Intro. to Construction Engineering Technology **	ETC	101	(3)
Construction Drafting/Lab	ETC	130/L	(2/1)
Construction Surveying I/Lab***	ETC	131/L	(2/2)
Construction Surveying II/Lab	ETC	132/L	(2/2)
Construction Drafting II/Lab	ETC	140/L	(2/1)
Construction Materials	ETC	202	(3)
Construction Inspection	ETC	204	(3)
Construction Plans and Specifications/Lab	ETC	230/L	(1/2)
Advanced Computer Appl. & E-construction/Lab	ETC	250/L	(3/1)
Electrical Installations/Lab	ETC	270/L	(3/1)
Construction Accounting/Lab	ETC	279/L	(2/1)
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 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/Lab	ETC	411/L	(3/1)
Concrete Mix Design/Lab	ETC	431/L	(1/1)
Undergraduate Seminar	ETT	460	(2)
Senior Project I	ETT	461	(2)
Senior Project II	ETT	462	(2)

** ETT 101/L may be substituted for ETC 101

***CE 134/L may be substituted for ETC 131/L

SUPPORT COURSES FOR CONSTRUCTION ET (42 units)

The following major support courses should be used to satisfy the indicated GE requirements. If these courses are not used to satisfy GE, the total units to degree may be more than 198 units.

General Chemistry Lab (B3)	CHM	121L	(1)
Applied Statics	ETT	210	(3)
Strength of Materials for ET/Lab	ETT	220/L	(3/1)
Engineering EconomicAnalysis	ETT	305	(4)
Applied Fluid Mechanics/Lab	ETT	310/L	(3/1)
Technical Electives (consult department advisor)			(12)
General Chemistry	CHM	121	(3)
Technical Calculus (B4)	MAT	130	(4)
Technical Calculus II	MAT	131	(4)
College Physics and Lab (B1, B3)	PHY	121/L	(4)
College Physics	PHY	122/L	(3/1)
College Physics	PHY	123/L	(3/1)

CORE COURSES FOR ELECTRONICS AND COMPUTER ENGINEERING TECHNOLOGY MAJORS (80 units)

D-C Circuit Analysis/Lab	ETE	102/L	(3/1)
A-C Circuit Analysis/Lab	ETE	103/L	(3/1)
Semiconductor Devices and Circuits/Lab	ETE	204/L	(3/1)
Electrical Circuit Analysis/Lab	ETE	210/L	(3/1)
Introduction to Digital Logic/Lab	ETE	230/L	(3/1)
Electronic Mfg and PCB Fabrication/Lab	ETE	272/L	(3/1)
Industrial Electronics/Lab	ETE	280/L	(3/1)
Electronic Devices and Circuits/Lab	ETE	305/L	(3/1)
Applied Network Analysis/Lab	ETE	310/L	(3/1)
Applied Numerical Methods with C++/Lab	ETE	312/L	(3/1)
Digital Logic Systems/Lab	ETE	315/L	(3/1)
Communication Systems/Lab	ETE	335/L	(3/1)
Microprocessor Systems and Applications/Lab	ETE	344/L	(3/1)
Feedback Systems Technology/Lab	ETE	350/L	(3/1)
Technical Communications and Project Management for ECET/Lab	ETE	401/L	(3/1)
Electronic Test Instrumentation with LabVIEW/Lab	ETE	420/L	(3/1)
Digital Data Communications and Networks/Lab	ETE	442/L	(3/1)
Applied C Programming/Lab	ETT	215/L	(3/1)
Senior Project I	ETT	461	(2)
Senior Project II	ETT	462	(2)

SUPPORT COURSES FOR ELECTRONICS AND COMPUTER ENGINEERING TECHNOLOGY MAJORS (50 units)

The following major support courses should be used to satisfy the indicated GE requirements. If these courses are not used to satisfy GE, the total units to degree may be more than 198 units.

General Chemistry	CHM	121	(3)
Computer Applications for ET/Lab	ETT	101/L	(2/1)
Applied Statics	ETT	210	(3)
Applied Dynamics	ETT	211	(3)
Material Science for ET	ETT	217	(3)
College Physics	PHY	122/L	(3/1)
College Physics	PHY	123/L	(3/1)
Technical Calculus II	MAT	131	(4)
Technical Calculus III	MAT	132	(4)
CAD elective (typically MFE126/L)			(3)
Technical electives (consult department advisor)			(16)
General Chemistry Lab (B3)	CHM	121L	
(1)Technical Calculus (B4)	MAT	130	(4)
College Physics and Lab (B1, B3)	PHY	121/L	(4)

CORE COURSES FOR ENGINEERING TECHNOLOGY- General (111 units)

Introduction to Engineering Technology/Lab	ETT	101/L	(2/1)
Electrical Technology/Lab	ETT	201/L	(3/1)
Applied Statics	ETT	210	(3)
Applied Dynamics	ETT	211	(3)
Applied C Programming/Lab	ETT	215/L	(3/1)
Material Science for ET	ETT	217	(3)
Strength of Materials for ET/Lab	ETT	220/L	(3/1)
Materials Joining/Lab	ETT	234/L	(1/1)
Engineering Economic Analysis for ET	ETT	305	(4)
Applied Fluid Mechanics I/Lab	ETT	310/L	(3/1)
Electronic Devices and Systems/Lab	ETT	321/L	(3/1)
Undergraduate Seminar	ETT	460	(2)
Senior Project I	ETT	461	(2)
Senior Project II	ETT	462	(2)
Applied Thermodynamics	ETM	306	(4)
Applied Heat Transfer	ETM	308	(4)
Applied Fluid Mechanics II	ETM	312	(4)
Instrumentation and Control Applications/Lab	ETM	330/L	(3/1)
Internal Combustion Engines/Lab	ETM	410/L	(3/1)
Engineering Graphics/Lab	MFE	126/L	(2/1)
Manufacturing Processes I — Material			

Removal/Lab	MFE	221/L	(2/1)
Engineering Graphics II/Lab	MFE	226/L	(2/1)
Manufacturing Processes II—Forming, Casting and Joining/Lab	MFE	230/L	(2/1)
Electives chosen with Department Approval			(35)

SUPPORT COURSES FOR ENGINEERING TECHNOLOGY – General (19 units)

General Chemistry	CHM	121	(3)
General Chemistry Lab (B3)	CHM	121L	(1)
Technical Calculus (B4)	MAT	130	
(4)Technical Calculus II	MAT	131	(4)
Technical Calculus III	MAT	132	(4)
College Physics and Lab (B1, B3)	PHY	121/L	(4)
College Physics	PHY	122/L	(3/1)
College Physics	PHY	123/L	(3/1)

GENERAL EDUCATION REQUIREMENTS

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 your catalog.

Area A (12 units)

1. Oral Communication
2. Written Communication
3. Critical Thinking

Area B (16 units)

1. Physical Science
2. Biological Science
3. Laboratory Activity
4. Math/Quantitative Reasoning
5. Science and Technology Synthesis

Area C (16 units)

1. Visual and Performing Arts
2. Philosophy and Civilization
3. Literature and Foreign Languages
4. Humanities Synthesis

Area D (20 units)

1. U.S. History, Constitution, and American Ideals
2. History, Economics, and Political Science
3. Sociology, Anthropology, Ethnic, and Gender Studies
4. Social Science Synthesis

Area E (4 units)

Lifelong Understanding and Self-development

COURSE DESCRIPTIONS

Lecture and laboratory courses listed together are to be taken concurrently.

ET Core Courses

ETT 101/L Computer Applications for Engineering Technology/Laboratory (2/1)

Introduction to engineering technology. Use of the personal computer for engineering problem-solving, documentation, and project management using current software application packages. Independent computer projects required. 2 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: College-level math or consent of instructor.

ETT 200 Special Study 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/L Electrical Technology/Laboratory (3/1)

Introduction to DC and AC circuit theory and applications involving resistance, inductance, and capacitance; characteristics of passive filters; operation and application of basic electrical measuring instruments. 3 lectures/problem-solving. 1 three-hour laboratory. Prerequisite: PHY 123/L. Not open to ECET majors.

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 lectures/problem-solving. Prerequisites: MAT 105, MAT 106, 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 lectures/problem-solving. Prerequisites: ETT 210, MAT 131.

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

Introduction to structured programming using ANSI C. Programming problems applicable to engineering technology. 3 lectures/problem-solving. 1 three-hour laboratory. Prerequisites: ETT 101, college-level math.

ETT 217 Materials Science for Engineering Technology (3)

Concepts of the structure and properties of materials and their relevance to industrial applications, properties of metals, ceramics, plastics, composites, and semiconductors. 3 lectures/problem-solving. Prerequisites: CHM 121, PHY 121.

ETT 220/L 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 lectures/ problem-solving and 1 three-hour laboratory. Prerequisites: ETT 210, MAT 130.

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

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

ETT 270, 470 Engineering Technology Internship (1–3) (1–3)

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: engineering technology related employment. Advance approval by internship coordinator required via a written proposal, and a letter of intent from the sponsoring employer. 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. Instruction is by lecture, laboratory, or a combination.

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 lectures/problem-solving. Prerequisites: College-level math; ETT 101/L or ETC 101.

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

Properties of fluids. Applied principles of fluid flow. Pressure forces on plane and curved surfaces. Viscous flow in pipes and open channels. 3 lectures/problem-solving; 1 laboratory. Prerequisites: ETT 210, MAT 131.

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

A survey study of electronics including logic systems; PLCs; motors; amplifiers, tuned circuits, oscillators, electro-optics, computer systems and networks. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: ETT 201/L. Not open to ECET majors.

ETT 400 Special Study 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 proposal, 2 seminars per week. Preparation for FE examination. Prerequisites: senior standing in major coursework.

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. With advisor approval, Construction (CET) students may substitute ETC 490 for ETT 461 and ETT 462. Prerequisites: ETT 460 or ETE 401, and senior standing.

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. Instruction is by lecture, laboratory, or a combination.

CONSTRUCTION ET COURSES

ETC 101 Introduction to Construction Engineering Technology (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 personal computers and applications. 3 lectures/problem-solving. Prerequisite: college-level math.

ETC 130/L Construction Drafting I/Laboratory (2/1)

Engineering graphics for the development and interpretation of construction drawings. Emphasis on learning the basic tools needed to draw and visualize both two and three dimensional objects. Composition of design and construction drawings using CAD software and hand drafting. Introduction to orthographic projection, auxiliary views, dimensioning and exercises that focus on composing construction details and sections. Adherence to an acceptable CAD standard in the placement and manipulation of graphical elements. Use of a laboratory facility and standard drafting equipment to compose construction drawings. 2 lectures and 1 three-hour laboratory.

ETC 131/L 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 lectures/problem-solving, 2 three-hour laboratories. Prerequisite: MAT 105 and MAT 106.

ETC 132/L 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 lectures/problem-solving, 2 three-hour laboratories. Prerequisite: ETC 131/L.

ETC 140/L Construction Drafting II/Laboratory (2/1)

Engineering graphics for the development and interpretation of construction drawings. Emphasis on learning the advanced tools needed to compose and visualize both two and three dimensional design. Use of CAD software to develop 3-dimensional static and animated models depicting construction engineering design. Use of software to develop computer-aided design tools for analytical interpretation of construction projects. 2 lectures and 1 three-hour laboratory. Prerequisite: ETC 130/L.

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 lectures/problem-solving. Corequisite: ETC 230/L.

ETC 204 Construction Inspection (3)

Introduction to construction inspection, functions, responsibilities, authority and technical requirements related to construction. 3 lectures/problem-solving.

ETC 230/L Construction Plans 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/problem-solving, 2 three-hour laboratories. Corequisite: ETC 202. Prerequisite: ETC 130 or MFE 126.

ETC 250/L Advanced Computer Applications and E-Construction/ Laboratory (3/1)

Applied Construction Engineering Programming for the development of structured routines useful in the construction engineering profession. Emphasis on understanding program composition, operators and functions compiled using Visual Basic. Use of Microsoft applications to develop macros and utilities that automate formatting tasks used in construction engineering reports and proposals. Exposure to HTML code for the development of interactive Intranet/Internet sites and e-construction. 3 lectures and 1 three-hour laboratory. Prerequisite: ETC

101.

ETC 270/L 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/problem-solving and 1 three-hour laboratory. Prerequisites: college algebra and trigonometry. Not open to ECET majors.

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

Fundamentals and practices of financial and management accounting in the construction industry, including accounting processes, internal control, cost elements, overhead allocation and financial reports. 2 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: ETC 202.

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

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 lectures/problem-solving. Prerequisites: ETC 202, ETC 230/L and MAT 130.

ETC 305 Construction Estimating II (4)

Fundamentals of heavy construction estimating procedures considering both quantity survey and pricing. 4 lectures/problem-solving. Prerequisites: ETC 131/L, ETC 304, ETC 312, MAT 131.

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 lectures/problem-solving. Prerequisites: ETT 220, MAT 131.

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 lectures/problem-solving. Prerequisites: ETC 202, ETC 230/L.

ETC 315 Timber and 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 lectures/problem-solving. Prerequisites: ETC 311, MAT 131.

ETC 316 Steel Design (3)

Design of structural steel elements including tension members, columns, beams, and beam-columns using load and resistance factor design (LFRD). Design of welded and bolted connections. AISC specifications. 3 lectures/problem-solving. 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 lectures/problem-solving. Prerequisite: ETC 311.

ETC 401 Construction 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 lectures/problem-solving. Prerequisite: ETC 304.

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 lectures/problem-solving. Prerequisites: senior standing, ETC 202, ETC 230/L.

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. Corequisite: ETC 204.

ETC 405 Construction Planning and Scheduling (3)

Methods and procedures used in planning and scheduling construction projects using graphic charts and CPM networks. Resource allocations, leveling and cost curves. Application of manual and computer network systems. 3 lectures/problem-solving. Prerequisite: ETC 304.

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 a project. 3 lectures/problem-solving. Prerequisite: ETC 304.

ETC 411/L 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: ETT 220.

ETC 431/L 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. Prerequisite: ETC 202.

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. Instruction is by lecture, laboratory, or a combination.

ELECTRONICS AND COMPUTER ET COURSES

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

Principles of electric circuit elements including resistance and DC network theorems. Capacitance, transients in RC circuits. 3 lectures/problem-solving. 1 three-hour laboratory. Prerequisites: MAT 105.

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

Principles of inductance and magnetism; transients in RL circuits. Phasor analysis in AC circuits; basic AC circuit theorems; transformers. 3

lectures/problem-solving. 1 three-hour laboratory. Prerequisites: C- or better in ETE 102, MAT 106.

ETE 204/L Semiconductor Devices and Circuits/Laboratory (3/1)

Characteristics and applications of solid-state diodes. Characteristics and biasing of BJT devices in CB, CE, CC amplifier configurations – load lines, input/output impedance and mid-band gain calculations. Characteristics and biasing of JFET devices and amplifiers, including load lines, input/output impedances and mid-band gain calculation. 3 lectures/ problem-solving and 1 three-hour laboratory. Prerequisite: C- or better in ETE 103.

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

RLC circuits, transfer functions, frequency response, Bode plots, passive filters, and resonance. 3 lectures/problem-solving. I three-hour laboratory. Prerequisite: C- or better in ETE 103.

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

Number systems and conversions, theory and practice of fundamental and universal gates, SOP and POS interconnections and conversions, simplification theorems, applied design of MSI and LSI logic and programmable logic devices. A/D code conversions. 3 lectures/problem-solving and 1 three-hour laboratory. Computer methods utilized. Prerequisite: C- or better in ETE 204.

ETE 272/L Electronic Manufacturing. PCB Fabrication/Laboratory (3/1).

Manufacturing and fabrication processes associated with the electronics industry. Introduction to hardware design. Testing/QA processes. PCB artwork and manufacturing techniques. 3 lectures/ problem-solving and 1 three-hour laboratory. Prerequisites: CAD, ETE 204, 230.

ETE 280/L Industrial Electronics/Laboratory (3/1)

Modern industrial electronics and control devices - relays, contactors, DC and AC motors; stepper motors; three-phase power and its control, optoelectronic devices, SCRs, Triacs and other thyristor devices; PLCs and ladder diagrams; introduction to control systems. 3 lectures/problem-solving, 1 three-hour laboratory. Prerequisites: ETE 204, 210, 230.

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. Instruction is by lecture, laboratory, or a combination.

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

Frequency dependent models for BJT and FET amplifiers, frequency effects upon gain and input-output impedance of single and multistage BJT and FET amplifiers, Bode plots, differential amplifiers. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: ETE 204, 210, MAT 131.

ETE 310/L Applied Network Analysis/Laboratory (3/1)

Analysis of circuits in the time and frequency domains employing Laplace transforms methods. Ideal op-amps and applications. Second order passive and active circuits, circuit responses to a variety of input signals, stability analysis of closed loop systems. Computer methods utilized. 3 lectures/problem-solving, 1 three-hour laboratory. Prerequisites: ETE 210; MAT 131.

ETE 312/L Advanced Programming with C++/Laboratory (3/1)

Introduction to C++ including console input/output, file input/output, function overloading, class structures, arrays, composition, single and multiple inheritance, virtual functions; and techniques for building class libraries. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: ETT 215.

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

Introduction to sequential logic circuits, latches and flip-flops and their applications, state diagram, state table, state machines (Mealy and Moore) design, state machine converter, state machine with and without control inputs, state reduction, analysis and design of clocked sequential circuits, analysis of timing diagrams, complex sequential logic circuit design and serial data code conversion, state machine design with algorithmic state machines. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: ETE 230, ETT 215.

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

Op-amp applications including integrators and differentiators; active filters, Schmitt triggers, oscillators, and wave shaping circuits. Op-amp characteristics. DC offsets and compensation; slew-rate limiting; open and closed-loop bandwidth, stability and compensation. 3 lectures/ problem solving and 1 three-hour laboratory. Prerequisites: ETE 305, 310.

ETE 335/L Communication Systems/Laboratory (3/1)

Introduction to periodically gated, amplitude, single sideband, frequency and phase modulation methods involved in communications systems. Introduction to digital modulation communication techniques. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: ETE 305, 310, MAT 132.

ETE 344/L Microcontroller Systems and Applications/Laboratory (3/1

Microprocessor/microcontroller organization, operation, assembly-language programming and input/output applications. A/D conversions and real-time interrupts. 3 lecture problems. 1 three-hour laboratory. Prerequisite: ETT 215.

ETE 350/L Feedback Systems Technology/Laboratory (3/1)

Modeling of continuous systems in the time and frequency domains, block diagrams, first and second order system response, reduction of multiple subsystems, feedback control systems, transient response, steady state behavior of feedback systems, sensitivity, stability analysis using Routh-Hurwitz and root locus techniques. Sample systems include servo motors and phase-locked loops. Computer methods utilized. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: ETE 272, 305, 310, MAT 132.

ETE 401/L Technical Communications and Project Management for ET/Laboratory (3/1)

Writing and interpreting engineering information related to electronics –research papers, technical and senior project proposals, engineering specifications, oral reports; project management techniques and use of project management software. Computer methods utilized. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: Satisfaction of GWT, ETE 272, 305, 310, 344.

ETE 412/L Introduction to Windows Programming/Laboratory (3/1)

Introduction to Windows application programming using API functions—menus, controls; use of class libraries. 3 lecture problems

and 1 three-hour laboratory. Prerequisite: ETE 312 or equivalent.

ETE 414/L 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: ETE 305, 310.

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

Fundamentals of electronic test instrumentation and computer data acquisition systems, theory and function of electronic measurements, op-amp applications and signal conditioning, sensors applications such as strain gage and temperature. Computerized data acquisition and programmable instrument control (IEEE - 488) utilizing LabVIEW graphical programming software. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: ETE 305, 310.

ETE 437/L 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, Network Analyzer usage and measurements. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: ETE 335.

ETE 438/L Microwave and RF Systems/Laboratory (3/1)

Microwave and RF measurement systems and techniques. Passive and active high frequency discrete circuit design. Microwave safety, generation, transmission, waveguides, waveguide components. Survey of modern microwave applications: radar, terrestrial and satellite communication systems. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: ETE 437.

ETE 442/L Data Communications and Networking/Laboratory (3/1)

Signal conversion methods, sampling, quantization, pulse modulation techniques, error analysis methods, digital modulation techniques, encoding schemes, data transmission methods, open system interconnection model, local area networks, transmission control protocol, internet protocol (TCP/IP), ethernet, IEEE 802 networking technology. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: ETE 335.

ETE 445/L PC–based Microprocessor Systems/Laboratory (3/1)

Organization, software model, and assembly-language programming of the 80xxx family of personal computers—applications, input/output programming, interrupts, use of the macro assembler. 3 lecture problems. 1 three-hour laboratory. Prerequisites: ETE 344.

ETE 446/L 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: ETE 305, 310.

ETE 450/L DSP and Digital Control Systems/Laboratory (3/1)

Introduction to digital signal processing, sampling techniques; zero-order hold circuits, z-transforms and difference equations; digital controllers; digital filters, frequency and phase response; applications of digital controllers (DID) in closed-loop feedback systems. 3 lecture problems and 1 three-hour laboratory. Prerequisites: ETT 215, ETE 350, 344.

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. Instruction is by lecture, laboratory, or a combination.

Engineering Technology Major Courses:

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. Instruction is by lecture, laboratory, or a combination.

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 thermodynamics as applied by the engineering technologist. Use of generalized charts and handbooks in solving thermodynamic problems. 4 lectures/problem-solving. Prerequisites: ETT 211, ETT 310, MAT 131.

ETM 308 Applied Heat Transfer (4)

Application of basic principles governing the three modes of heat transfer: conduction, convection and radiation. Empirical and practical relations for forced convection heat transfer and heat exchanger analysis and design 3 lectures/problem-solving. Prerequisites: ETM 306, ETM 312, MAT 132.

ETM 312 Applied Fluid Mechanics II (4)

Introduction to fluids in motion, differential and integral forms of governing equations, non-dimensional analysis and similitude; laminar and turbulent flow; gas dynamics. 4 lecture problems. Prerequisites: ETT 310, ETM 306.

ETM 315/L 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 lectures/problem-solving, 1 three- hour laboratory. Prerequisites: ETT 220; PHY 121, MFE 126/L.

ETM 320/L 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: ETM 315.

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

A study of the elements of mechanisms; cams, gears, kinematics. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: ETT 211, MAT 131, PHY 121.

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

Theory of application of strain gages, pressure gages, and other transducer types for instrumentation and control of electromechanical systems. This will include velocity, displacement, frequency and time response. Prerequisites: MAT 132, ETT 321, ETM 306, ETT 310.

ETM 334 Applied Heating and Air Conditioning (4)

Thermal environmental requirements for human habitation. Psychometrics. Building heating and cooling loads. Air-handling

equipment. 4 lectures/problem-solving. Prerequisites: ETM 306, ETT 310.

ETM 335/L 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: ETM 334.

ETM 405L Wind Tunnel Testing Laboratory (2)

Low speed wind tunnel testing of bodies of various shapes, such as automobiles, bridges, and buildings, etc., to experimentally determine their aerodynamic drag and lift characteristics. 2 three-hour laboratories. ETM 306, 312.

ETM 410/L Internal Combustion Engines/Laboratory (3/1)

Theory and performance of internal combustion engines—compression, carburetion, fuel injection, ignition, and cooling; power takeoff, use of instrumentation. Selection and rating of fuels. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: ETM 306, 312.

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. Instruction is by lecture, laboratory, or a combination.

ETP 276/L 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 lectures/problem-solving and 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. Instruction is by lecture, laboratory, or a combination.

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 lectures/problem-solving. 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 lectures/problem-solving. Prerequisite: junior standing.

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

Concepts and methods of planning for manufacturing processes and plant layout and facilities are covered. Local ordinance, lighting, fire safety and their impact on building design are emphasized. Scheduling, type of manufacturing processes, and material and inventory handling systems are discussed. 3 lecture-problems, 1 three-hour laboratory. Prerequisite: MFE 126L or CAD class; Apparel Manufacturing students, junior level.

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 lectures/problem-solving. Prerequisites: ETT 215, MAT 131, course in fundamentals of statistics.

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 lectures/problem-solving. Prerequisites: senior standing, ETT 305.

ETP 437/L, 438/L 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-solving and 1 three-hour laboratory. Prerequisite: ETT 217.

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. Instruction is by lecture, laboratory, or a combination.

INDUSTRIAL AND MANUFACTURING ENGINEERING

Abdul B. Sadat, Chair

Kamran Abedini
Farouk Darweesh
Biman K. Ghosh
Victor Okhuysen
Phillip R. Rosenkrantz

The department offers two degree programs, one in Industrial Engineering and one in Manufacturing Engineering. The Industrial Engineering program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. The Manufacturing Engineering program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. 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 Pomona. 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 students for direct entry into the engineering profession as well as graduate school.

The department of Industrial and Manufacturing Engineering is concerned about the success of its graduates as they matriculate into the industrial world and during their careers as engineers. The department is also concerned about its curricula: Does it meet the demands of industry and the profession? For these reasons the department conducts both formal and informal outcome assessments of the progress of its graduates and the value of its curricula. Assessment is conducted by quarterly interaction with its Industry Advisory Council, by surveys of its graduates, and by surveys of the employers of its graduates. As areas needing change are identified, they are carefully considered by the faculty, prior to the implementation of any changes. Curriculum changes are made through the normal change channels, and the results are monitored for effectiveness. In this manner the department is able to assure itself that its curricula are state-of-the art and remain so.

Both degree programs share the following objectives:

- Prepare the student to function and provide leadership in today's highly technical environment;
- Enhance the student's ability to communicate by oral, graphic, written and electronic means to describe engineering challenges and their solutions;
- Prepare students to solve unstructured problems through analytical means and to synthesize, analyze, and critically evaluate their solutions;
- Develop a knowledge of and appreciation for the solution of engineering problems through the use of teams;
- Instill the habit of life-long learning and professional growth in engineering practice;
- Develop the competence in the chosen discipline to assure that the graduate possesses the methodological and computational skills necessary to succeed in that field; and
- Assure that the graduate appreciates the moral, ethical and legal implications of engineering decisions.

INDUSTRIAL ENGINEERING

Industrial engineering is a dynamic profession with credible growth and increasing importance. Industrial engineers use engineering principles to design, develop, implement and improve integrated systems that include people, materials, information, equipment, and energy. 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.

The 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 and the Society of Manufacturing Engineers.

The Industrial Engineering program consists of 198 quarter units: 69 quarter units of Core courses, 61 units of Support and Directed Elective courses, and 68 units of General Education. 12 quarter units of upper division General Education must be completed at Cal Poly Pomona.

CORE COURSES FOR MAJOR

Required of all students. A 2.0 cumulative GPA is required in core courses in order to receive a degree in the major.

Fundamentals of Human Factors Engineering	IE	225/L	(3/1)
Systems Engineering	IE	327/L	(3/1)
Operations Research I	IE	416	(4)
Operations Research II	IE	417	(4)
Discrete Systems Simulation	IE	429/L	(3/1)
Operations Planning and Control	IE	436/L	(2/1)
Industrial and Manufacturing Engineering Fundamentals	IME	112	(3)
Industrial and Manufacturing Engineering Computations Laboratory	IME	113/L	(2/1)
Work Analysis and Design	IME	224/L	(3/1)
Industrial Costs and Controls	IME	239	(3)

Application of Statistics in Engineering	IME	301	(3)
Engineering Probability and Statistics	IME	312	(3)
Supply Chain Planning and Control	IME	326	(3)
Facilities Planning, and Material Handling	IME	331/L	(3/1)
Statistical Quality Control	IME	415/L	(3/1)
Senior Project Seminar	IME	460	(1)
Senior Project	IME	461 or 471	(2)
Senior Project	IME	462 or 472	(3)
Analytic Geometry and Calculus II	MAT	115	(4)
Analytic Geometry and Calculus III	MAT	116	(4)
Calculus of Several Variables I	MAT	214	(3)
Calculus of Several Variables II	MAT	215	(3)
Elementary Linear Algebra and Differential Equations	MAT	224	(4)
Engineering Graphics I	MFE	126/L	(2/1)
Manufacturing Systems Processes	MFE	201/L	(3/1)
Introduction to Computer Integrated Manufacturing	MFE	450/L	(3/1)
General Physics	PHY	132/L	(3/1)
General Physics	PHY	133/L	(3/1)

IE electives (from approved list) . . . . . (7)

SUPPORT AND ELECTIVE COURSES

The following major support courses should be used to satisfy the indicated GE requirements. If these courses are not used to satisfy GE, the total units to degree may be more than 198 units.

General Chemistry	CHM	121	(3)
General Chemistry Lab (B3)	CHM	121L	(1)
General Chemistry	CHM	122/L	(3/1)
Principles of Economics (D2)	EC	201	(4)
or Principles of Economics (D2)	EC	202	(4)
Elements of Electrical Engineering	ECE	231/L	(3/1)
Ethical Considerations (C4)	EGR	402	(4)
Asset Allocation in Technical Decision Making (D4)	EGR	403	(4)
Analytic Geometry and Calculus I (B4)	MAT	114	(4j
Vector Statics	ME	214	(3)
Strength of Materials I	ME	218	(3)
Materials Science and Engineering	MTE	207	(3)
General Phvsics and Lab (B1, B3)	PHY	131/L	(3/1)

Engineering Science Electives . . . . . (7)

GENERAL EDUCATION REQUIREMENTS

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

Area A (12 units)

1. Oral Communication
2. Written Communication
3. Critical Thinking

Area B (16 units)

1. Physical Science
2. Biological Science
3. Laboratory Activity
4. Math/Quantitative Reasoning
5. Science and Technology Synthesis

Area C (16 units)

1. Visual and Performing Arts
2. Philosophy and Civilization
3. Literature and Foreign Languages
4. Humanities Synthesis

Area D (20 units)

1. U.S. History, Constitution, and American Ideals
2. History, Economics, and Political Science
3. Sociology, Anthropology, Ethnic, and Gender Studies
4. Social Science Synthesis

Area E (4 units)

Lifelong Understanding and Self-development

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 one of only two 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 laboratory assignments, projects, field trips, trade shows, and co-op work. Students get laboratory experience in metal-removal processes, metal casting, forming and assembly, computer numerical control, robotics, and CAD/CAM.

Manufacturing Program Objectives

Manufacturing Engineering graduates will:

a. Enjoy successful careers in industry, research or academia.

b. Continue to pursue knowledge and professional growth.

c. Perform leadership roles by enhancing collaboration between engineers, scientists, professional and business people.

d. Contribute as professionally, ethically, and globally aware members of society.

e. Engage in the design and integration of materials transformation and production processes.

f. Positively impact the financial performance of manufacturing enterprises.

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, rapid prototyping, 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.

The department is fortunate in having an Industrial Advisory Council composed of professionals from local industry. The council assists the department in many ways; reviewing the program to assure its applicability, providing opportunities for student internships or summer work, acting as a source for new processes and techniques, and providing financial support either directly or through providing material and equipment. The council and the department have regular meetings each quarter to discuss the progress of the program.

The Manufacturing Engineering curriculum detailed below prepares the graduate to excel in today's highly technical industrial environment. The educational objectives reflect outcomes as assessed by employers, graduates, and the industrial community. Program emphasis is placed on developing competence in manufacturing engineering functions, written and oral communications, teamwork, and the ability to integrate complex, interdisciplinary, manufacturing systems.

Manufacturing engineering students are encouraged to join the student chapter of the Society of Manufacturing Engineers. They can also join student chapters of the American Foundrymen's Society and the Institute of Industrial Engineers. Eligible students may be invited to join Alpha Pi Mu, the industrial engineering honor society.

The Manufacturing Engineering Program consists of 198 quarter units: 75 or 76 quarter units of Core Courses, 54 or 55 quarter units of Support and Directed Elective Courses, and 68 quarter units of General Education. 12 quarter units of upper division General Education must be completed at Cal Poly Pomona. The difference in the number of quarter units in Core and Support is caused by the student's choice of Fluid Mechanics or Thermodynamics.

CORE COURSES FOR MAJOR

Required of all students. A 2.0 cumulative GPA is required in core courses for the major in order to receive a degree in the major.

Discrete Systems Simulation	IE	429/L	(3/1)
Industrial and Manufacturing Engineering Fundamentals	IME	112	(3)
Industrial and Manufacturing Engineering Computations/Laboratory	IME	113/L	(2/1)
Industrial Costs and Controls	IME	239	(3)
Application of Statistics in Engineering	IME	301	(3)
Engineering Probability and Statistics	IME	312	(3)
Supply Chain Planning and Control	IME	326	(3)
Facilities Planning, and Material Handling	IME	331/L	(3/1)
Statistical Quality Control	IME	415/L	(3/1)
Senior Project Seminar	IME	460	(1)
Senior Project	IME	461 or 471	(2)
Team Senior Project	IME	462 or 472	(3)
Analytic Geometry and Calculus II	MAT	115	(4)
Analytic Geometry and Calculus III	MAT	116	(4)
Calculus of Several Variables I	MAT	214	(3)
Calculus of Several Variables II	MAT	215	(3)
Elementary Linear Algebra and Differential Equations	MAT	224	(4)
Engineering Graphics I	MFE	126/L	(2/1)
Manufacturing Processes-Materials, Metrology and Treatments	MFE	217/L	(2/1)
Manufacturing Processes I-Material Removal	MFE	221/L	(2/1)
Engineering Graphics II	MFE	226/L	(2/1)
Manufacturing Processes II-Form, Cast, and Join	MFE	230/L	(2/1)
Principles of Numerical Control	MFE	250/L	(2/1)
Measurement and Methods/Laboratory	MFE	320/L	(3/1)
Design for Manufacturing/Laboratory	MFE	326/L	(3/1)
CAD/CAM/Lab	MFE	375/L	(3/1)
Introduction to Computer Integrated Manufacturing	MFE	450/L	(3/1)
Metal Working Theory and Applications	MFE	465	(3)
Advanced CAM Systems/Laboratory	MFE	476/L	(3/1)
General Physics	PHY	132/L	(3/1)
General Physics	PHY	133/L	(3/1)

Manufacturing Electives (selected with advisor's approval) . . . . . (3-4)

SUPPORT AND DIRECTED ELECTIVE COURSES

The following major support courses should be used to satisfy the indicated GE requirements. If these courses are not used to satisfy GE, the total units to degree may be more than 198 units.

General Chemistry	CHM	121	(3)
General Chemistry Lab (B3)	CHM	121L	(1)
General Chemistry	CHM	122/L	(3/1)
Principles of Economics (D2)	EC	201	(4)
or Principles of Economics (D2)	EC	202	(4)
Asset Allocation in Technical Elements of Electrical Engineering	ECE	231/L	(3/1)
Ethical Considerations (C4)	EGR	402	(4)
Asset Allocation in Technical Decision Making (D4)	EGR	403	(4)
Analytic Geometry and Calculus I (B4)	MAT	114	(4j
Vector Statics	ME	214	(3)
Vector Dynamics	ME	215	(4)
Strength of Materials I	ME	218	(3)
Fluid Mechanics I	ME	311	(3)
or Thermodynamics I	ME	301	(4)
General Phvsics and Lab (B1, B3)	PHY	131/L	(4)

GENERAL EDUCATION REQUIREMENTS

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

Area A (12 units)

1. Oral Communication
2. Written Communication
3. Critical Thinking

Area B (16 units)

1. Physical Science
2. Biological Science
3. Laboratory Activity
4. Math/Quantitative Reasoning
5. Science and Technology Synthesis

Area C (16 units)

1. Visual and Performing Arts
2. Philosophy and Civilization
3. Literature and Foreign Languages
4. Humanities Synthesis

Area D (20 units)

1. U.S. History, Constitution, and American Ideals
2. History, Economics, and Political Science
3. Sociology, Anthropology, Ethnic, and Gender Studies
4. Social Science Synthesis

Area E (4 units)

Lifelong Understanding and Self-development

COURSE DESCRIPTIONS

Lecture and laboratory courses listed together are to be taken concurrently. The following classes are offered when demand is sufficient: IE 403, IE 426, IE 437, IME 328/L, MFE 305/L, MFE 310/L, MFE 373/L, MFE 406, MFE 438/L, MFE 439, MFE 440, MFE 484.

IE 225/L 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. ADA and OSHA standards. 3 lectures/problem-solving and 1 three-hour laboratory.

IE 327/L Systems Engineering/Laboratory (3/1)

Introduction to the theory of systems engineering. Establish needs, objectives, and the evaluation of solution effectiveness. Developing models and analysis. Introduction to Information Systems and database design. Application of heuristics. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: MAT 116, IME 224/L.

IE 392 Principles of Lean Implementation (3)

Lean characteristics, definitions, concepts, and trends. Use of various industrial engineering techniques in produtivity improvement. Relationship between productivity and profit. Phases of a productivity improvement project. Case studies. Plant visits and guest speakers. 3 lectures/ problem-solving.

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 lectures/problem-solving. Prerequisite: junior standing in engineering.

IE 416 Operations Research I (4)

Application of optimization techniques to the problems encountered in industry and business. Linear programming and sensitivity analysis. Transportation techniques. Linear integer and goal programming. Problem formulation and software applications. Analysis and report writing skills. 4 lectures/problem-solving/software demonstrations. Prerequisite: MAT 224.

IE 417 Operations Research II (4)

Applications of operations research techniques to the problems encountered in industry and business. Queuing theory, Markovian analysis, and decision theory. Problem formulation and software applications. Analysis and report writing skills. 4 lectures/problem-solving/software demonstrations. Prerequisite: IME 312.

IE 419 Reliability Concepts and Techniques (3)

Reliability concepts and techniques as used in various types of industrial applications. Quantitative and qualitative methods of reliability assessment. FMEA, Fault Tree Analysis, Accelerated Life Testing, and introduction to software reliability. 3 lectures. 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 lectures/problem-solving. Prerequisite: IME 312 or equivalent.

IE 429/L Discrete Systems Simulation/Laboratory (3/1)

Application of discrete event simulation concepts and tools to improve or design a system in industry (i.e. material handling) and business. System theory, data collection, verification and validation. Software applications. Analysis and report writing skills. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: IME 312.

IE 436/L 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: IE 327, IE 416, IME 326, IE 225.

IE 437 Advanced Systems Engineering (3)

Advanced 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 lectures/problem-solving. Prerequisite: IE 327.

IME 112 Industrial and Manufacturing Engineering Fundamentals (3)

Introduction to industrial and manufacturing engineering concepts, functions, lean manufacturing, teamwork, and project management. Study skills and time organization. Engineering communications. Team projects based on real industrial problems. 3 lectures/problem-solving.

IME 113/L Industrial and Manufacturing Engineering Computations/Laboratory (2/1)

Fundamentals of digital computer methods, logic diagramming, programming in a high-level language. Computer solutions of elementary industrial and manufacturing engineering problems. 2 lecture/problem-solving and 1 three-hour laboratory.

IME 224/L 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, computerized work measurement and work sampling. 3 lectures/ problem-solving and 1 three-hour laboratory.

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 lectures/problem-solving.

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. Instruction is by lecture, laboratory, or a combination.

IME 301 Application of Statistics in Engineering (3)

Statistical conclusions for problems observed in industry and business. Descriptive statistics, discrete and continuous distributions, hypothesis testing, control charts, factorial experiments and regression analysis. 3 lectures/problem-solving/software demonstrations. Prerequisite: MAT 115.

IME 312 Engineering Probability and Statistics (3)

Engineering applications of the concepts of probability, statistical

distributions, regression and correlation analysis, and hypothesis testing. 3 lectures/problem-solving. Prerequisites: IME 301 or equivalent, ENG 104.

IME 326 Supply Chain Planning and Control (3)

Principles of supply chain planning and control systems. Methods of forecasting, planning, scheduling, and controlling production, inventory and project activities. Quantitative models and computer systems. 3 lectures/problem-solving. Prerequisites: IME 224 and IE 312.

IME 328/L 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-solving and 1 three-hour laboratory. Prerequisites: basic electronic and drafting course.

IME 331/L Facilities Planning and Material Handling/Laboratory (3/1)

Concepts and methods used to design an effective facility layout and material handling system. Topics include determination of requirements for people, equipment, and space; development of concepts for material transport and storage, and evaluation of alternatives using CAD tools, analytical models, and simulation models. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: IME 326; MFE 126/L recommended.

IME 400 Special Study 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/L Statistical Quality Control (3/1)

Requirements of quality systems and their implementation. Process control techniques, statistical analysis and other methods used by management to control costs, improve quality, and meet customer requirements. Role of SQC in Supply Chain Management, six sigma quality, and other quality management systems. 3 lectures/problem-solving and 1 three-hour lab. Prerequisite: IME 312.

IME 435/L 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: IME 312.

IME 460 Senior Project Seminar (1)

In-depth instruction and discussion of requirements for senior project proposals, senior project reports, formal presentations, project management and teamwork, and professionalism in the workplace. 1 Seminar. Prerequisite: senior standing.

IME 461, 462 Senior Project (2) (3)

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 written and oral formal report. Minimum 120 hours total time. Prerequisites: IME 239, IME 460, EGR 403.

IME 471, 472 Team Senior Project (2) (3)

Selection and completion of a team project under the supervision of a faculty member. The project will be of sufficient magnitude to require the efforts of a team of students to complete within the allotted time. Project results are presented orally and in a formal written report. Prerequisites: IME 239, IME 460, EGR 403.

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. Instruction is by lecture, laboratory, or a combination.

MFE 126/L 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 lectures/problem-solving and 1 three-hour laboratory.

MFE 201/L 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. Product fee required. 3 lectures/problem-solving and 1 three-hour laboratory.

MFE 217/L Manufacturing Processes—Materials, Metrology and Treatments/Laboratory (2/1)

First in a three-course sequence. Provides basic knowledge of engineering materials and the enhancement of their mechanical properties; measurement methods and process controls. Statistical process control; heat treatment of materials; electronic manufacturing and surface technology. 2 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: CHM 121/L.

MFE 221/L Manufacturing Processes I--Material Removal/Laboratory (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 tools 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: MFE 217 or ETT 217 or equivalent.

MFE 226/L 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: MFE 126/L or equivalent.

MFE 230/L Manufacturing Processes II--Forming, Casting and Joining/Laboratory (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 introductory exposure to manufacturing systems. 2 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: MFE 217 or ETT 217 or equivalent.

MFE 250/L Principles of Numerical Control/Laboratory (2/1)

Principles and applications of numerical control in manufacturing, manual and computer-assisted programming, NC systems including advanced CNC systems for full contouring, macro- and variable programming, programmable controllers for CNC and DNC applications in industry. 2 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: MFE 126/L, and either MFE 201/L or MFE 221/L.

MFE 305/L Material Fabrication Processes/Laboratory (2/1)

Joining metals with an emphasis on their weldability, design and fabrication considerations, inspection and testing of weldments, and the design of the equipment for the most common welding and cutting processes. Included are the selection of the welding processes relative to the product, material type, and production requirements. Students will prepare weld joints that are properly designed, evaluate and test the quality of their weldments. 2 lecture/problem-solving, 1 three-hour laboratory. Prerequisite: MFE 201 or MFE 230.

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

Advanced commands and the development of skills in 3-D visualization, application of advanced drawing techniques for assembly modeling; wireframe and solid modeling. 2 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: MFE 126/L or equivalent.

MFE 320/L 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 lectures/problem-solving and 1 three-hour laboratory.

MFE 326/L Design for Manufacturing/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 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: MFE 226, MFE 250/L, and either MFE 230/L or MFE 201/L.

MFE 334/L Foundry Process Engineering/Laboratory (2/1)

Investigation of the various casting techniques characteristic of modern foundry practice. Green sand, sodium silicate, shell core, shell mold, investment, die casting and lost foam considered in relation to required molds, patterns, melting processes and materials. Computer applications include simulation software for mold system design. 2 lectures/problem-solving. Prerequisites: MFE 126, and either MFE 230 or MFE 201 or equivalents.

MFE 373/L Tool and Die Engineering/Laboratory (2/1)

Introduction to the fundamentals of tool and die design. Functions, components and appropriate manufacturing techniques, die life, maintenance, storage and safety. 2 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: MFE 221/L and MFE 230/L.

MFE 375/L 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: MFE 250/L and MFE 126/L or equivalent.

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

The science of engineering measurement as used in inspection and quality control. Emphasis on the general use of scientific measuring devices and measurement assurance. Automated measuring systems. Gage R&R studies. 1 lecture/problem-solving and 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 contaminant's in the workplace. Accident prevention. Material handling safety, machine guards and personal protection equipment. 3 lectures/problem-solving.

MFE 438/L Plastics Engineering I/Laboratory (3/1)

Plastic materials and their processing. Review of the pertinent organic chemistry of polymer materials. Classification, properties, characteristics and applications of plastics; polyethylene, PVC, ABS, polyesters, phenolics and urethanes. Study of processes including injection molding, extrusion, thermoforming and blowmolding; applications, process parameters, quality, economics and tooling considerations. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: MFE 230/L or MFE 201/L or equivalent.

MFE 439 Composites Manufacturing (2)

Current topics in plastics processing. Basics of composite properties; strength with respect to fiber loading-type and orientation. Processing methods for composite production; manual lay-up, vacuum, filament winding. 2 lectures/problem-solving.

MFE 440 Plastics Injection Molding and Tooling (4)

Theory and practical applications related to Plastics Injection processing and related tooling requirements in the processing of polymeric materials. Modern methods are explored with emphasis on the engineering principles to the production of marketable products. Topics include: Polymeric materials and properties, properties related to injection molding, equipment, process, plastic part design, tooling design and construction. Independent study as per designed course plan with the use of interactive training software and text. Consent of instructor is required and will be based on an interview with the student to assess ability to work independently and successfully complete the course as well as background knowledge. This knowledge can be obtained from previous coursework that includes materials and/or manufacturing procsses. Example classes include but are not limited to MFE 217/L, ETT 217/L, MFE 230/L, MFE 201/L, MFE 438/L, M T E 204, and ME 315. Student work experience in the field will also be considered.

MFE 450/L Introduction to Computer Integrated Manufacturing/Laboratory (3/1)

Mechanization/automation/mechatronics. Basic production concepts and strategies. Problems and methods of mechanization. Material handling systems. Robotics. Elements of automation sensors, analyzers, actuators and drives. Control strategies: industrial control, discrete time/event driven systems, feed back systems, and optimal control strategies. Robotic systems. NC machines. Automated inspection and identification techniques. Computer process control. Prerequisites: ECE 231/L, MFE 201 or MFE 250, MAT 224.

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 lectures/problem-solving. Prerequisites: MFE 221/L; MFE 230/L or MFE 201; ME 218.

MFE 476/L 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. Information Technology in Manufacturing. 3 lectures/problem-solving, 1 three-hour laboratory. Prerequisite: MFE 450.

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. 3 lectures/problem-solving. Prerequisite: MFE 326.

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. Instruction is by lecture, laboratory, or a combination.

MECHANICAL ENGINEERING

www.csupomona.edu/~me

Hassan M. Rejali, Chair

Kevin R. Anderson
John R. Biddle
John P. Caffrey
Chuan-Chiang Chen
Peter A. Dashner
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David L. Miller
Mariappan Jawaharlal
Parham Piroozan
Kathleen Puskar
Amir G. Rezaei
Angela Shih
Michael T. Shelton
Hong Xue

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/fluid sciences, 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 mechanical engineering curriculum permits students to explore different fields, specializing in one or more of them as they find their true interests. The Mechanical Engineering program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

The Mechanical Engineering program's mission is to provide a quality, well-rounded education that is based on imparting fundamental knowledge and skills in mathematics and pure science as well as engineering science and design, and prepare graduates who will be effective contributors to the Mechanical Engineering profession within a short time after their graduation. In particular, the curriculum is designed to:

- provide a solid background in mathematics and science coupled with an applications-oriented polytechnic approach in the presentation of engineering course material;
- provide a comprehensive program of general education courses that will impart to the students the necessary background to understand the economic, environmental, ethical, political, societal and cultural impact of their engineering solutions and decisions;
- develop good written and verbal communication skills;
- encourage lifelong learning in their chosen field;
- provide the necessary tools and background to become a professional engineer; and

During the junior and senior years students are required to take 12 units from one of 2 emphasis areas. These areas are Mechanical Design, and Energy Systems. All 12 units must be taken from the same emphasis area.

To receive credit for senior project, the students must successfully complete all lower division GE courses and all 300-level Mechanical Engineering courses. Successful completion means earning a grade of C- or better in all 300 ME courses that are prerequisites to other ME courses, except terminal courses that are solely prerequisites to senior project.

Principles developed in the classroom are applied to the operation of heat transfer equipment, fluid handling equipment, energy, energy systems, environmental control systems, internal and external combustion engines, mechanical systems, and testing of engineering materials.

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 must have successfully completed at least one year of college calculus and preferably one year of college physics (with laboratory) prior to beginning the program at Cal Poly Pomona. The community college students planning to transfer into this department should consult a school counselor or refer to assist.org to determine which courses meet the program requirements.

Mechanical engineers work in industry, business, government, universities, and in the 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, and the American Society of Heating, Refrigeration and Air Conditioning Engineers. Qualified students are invited to join the student chapter of Pi Tau Sigma, the mechanical engineering honor society.

REQUIRED CORE COURSES

Required of all students. A 2.0 cumulative GPA is required in core courses in order to receive a degree in the major.

Mechanical Engineering Orientation	ME	100L	(1)
Vector Statics	ME	214	(3)
Vector Dynamics	ME	215	(4)
Strength of Materials I	ME	218	(3)
Strength of Materials II	ME	219	(3)
Strength of Materials Laboratory	ME	220L	(1)
Mechanics Laboratory	ME	224L	(1)
Engineering Digital Computations	ME	232	(2)
Engineering Digital Computations Activity	ME	232A	(1)
Introduction to Mechanical Design	ME	233/L	(3/1)
Thermodynamics I	ME	301	(4)
Thermodynamics II	ME	302	(4)
Fluid Mechanics I	ME	311	(3)
Fluid Mechanics II	ME	312	(3)
Fluid Mechanics Laboratory	ME	313L	(1)
Engineering Materials	ME	315	(4)
Intermediate Dynamics	ME	316	(3)
Stress Analysis	ME	319	(4)
Machine Design	ME	325/L	(3/1)
Modeling and Simulation of Dynamic Systems	ME	340	(3)
Materials Science and Selection Laboratory	ME	350L	(1)
Finite Element Analysis	ME	406/A	(3/1)
Heat Transfer	ME	415	(4)
Air Conditioning	ME	418/L	(3/1)
or Thermal Systems Design	ME	427	(4)
Theory and Design for Mechanical Measurements	ME	435/L	(3/1)
Control of Mechanical Systems	ME	439/L	(3/1)
Analytic Geometry and Calculus II	MAT	115	(4)
Analytic Geometry and Calculus III	MAT	116	(4)
Calculus of Several Variables I	MAT	214	(3)
Calculus of Several Variables II	MAT	215	(3)
Linear Algebra and Differential Equations	MAT	224	(4)

General Physics	PHY	131/L	(3/1)
General Physics	PHY	133/L	(3/1)

REQUIRED TECHNICAL EMPHASIS COURSES

The Mechanical Engineering program requires each student to select one of technical emphasis courses. Two emphases, Mechanical Design, and Energy Systems are available to the students in order to satisfy this requirement of graduation. Each Mechanical Engineering student is required to specify three courses out of one of the two emphases as listed below and must adhere to that emphasis, no substitutions between emphases will be allowed. No other courses from any other department or university will be accepted as substitutes for these courses. The courses included in the two required technical emphasis courses pool are as follows:

MECHANICAL DESIGN EMPHASIS

Numerical Methods	ME	330	(4)
Acoustics and Noise Control	ME	405	(4)
Mechanical Vibrations	ME	413	(4)
Air Conditioning**	ME	418/L	(3/1)
or Thermal Systems Design**	ME	427	(4)
Dynamics of Machinery	ME	421	(4)
Advanced Machine Design	ME	425/L	(3/1)
Special Topics for Upper Division Students*	ME	499	(4)
Special Topics for Upper Division Students Activity+	ME	499A	(1)

ENERGY SYSTEMS EMPHASIS

Numerical Methods	ME	330	(4)
Alternative Energy Systems	ME	307	(4)
Solar Thermal Engineering	ME	407/L	(3/1)
Nuclear Engineering	ME	408	(4)
Heat Power	ME	411/L	(3/1)
Internal Combustion Engines	ME	412/L	(3/1)
Air Conditioning**	ME	418/L	(3/1)
or Thermal Systems Design**	ME	427	(4)
Special Topics for Upper Division Students*	ME	499	(4)
Special Topics for Upper Division Students Activity+	ME	499A	(1)

*ME 499 must be either a mechanical design emphasis, or an energy systems emphasis topic.

**ME 418/L or ME 427 may be taken depending on which one was used by the student to satisfy th ME major core requirement, i.e. if the student used ME 427 in ME major core requirement, he or she can take ME 418/L in the Energy Systems emphasis.

+ME 499A must be taken by all students and must be the Numerical Methods Activity topic.

SUPPORT COURSES

The following major support courses should be used to satisfy the indicated GE requirements. If these courses are not used to satisfy GE, the total units to degree may be more than 198 units.

General Chemistry I (B1, B3)	CHM	121/L	(3/1)
General Chemistry II	CHM	122	(3)
General Chemistry II Lab (B3)	CHM	122L	(1)
Principles of Economics (D2)	EC	201	(4)
or Principles of Economics (D2)	EC	202	(4)
Elements of Electrical Engineering.	ECE	231/L	(3/1)
Ethical Considerations in Technology and Applied Science (C4)	EGR	402	(4)
Asset Allocation in Technical Decision Making (D4)	EGR	403	(4)
Project Design Principles and Applications (B5)	EGR	481, 482	(4)
Analytic Geometry and Calculus I (B4)	MAT	114	(4)
Engineering Graphics I	MFE	126/L	(2/1)
Manufacturing Systems Processes	MFE	201/L	(3/1)

Students may receive senior project credit by taking EGR 481 and EGR 482, provided they satisfy all prerequisite requirements for senior project and get approval from the department by completing the department senior project form. For senior project prerequisites, please refer to prerequisites for ME 461 and ME 462.

GENERAL EDUCATION REQUIREMENTS

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

Area A (12 units)

1. Oral Communication
2. Written Communication
3. Critical Thinking

Area B (16 units)

1. Physical Science
2. Biological Science
3. Laboratory Activity
4. Math/Quantitative Reasoning
5. Science and Technology Synthesis

Area C (16 units)

1. Visual and Performing Arts
2. Philosophy and Civilization
3. Literature and Foreign Languages
4. Humanities Synthesis

Area D (20 units)

1. U.S. History, Constitution, and American Ideals
2. History, Economics, and Political Science
3. Sociology, Anthropology, Ethnic, and Gender Studies
4. Social Science Synthesis

Area E (4 units)

Lifelong Understanding and Self-development

COURSE DESCRIPTIONS

Lecture and laboratory courses listed together are to be taken concurrently.

For graduation, a grade of C- or better is required for all ME courses that are prerequisites to other ME courses.

Unless otherwise noted, all ME classes are open only to ME majors.

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. Introduction to engineering design. 1 three-hour laboratory. Corequisite: MAT 105.

ME 214 Vector Statics (3)

Two and three dimensional equilibrium of particles and rigid bodies including frames, machine and trusses employing vector algebra. Principles of friction, centroids and center of gravity, moments of inertia for areas. 3 lectures/problem-solving. Prerequisites: ARO, CE, CME, IE,

ME, or MFE major, ENG 104 or equivalent, C or better in MAT 115, and C- or better in PHY 131. Corequisite: (for ME majors only) ME 224L.

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, mass moment of inertia. 4 lectures/problem-solving. Prerequisites: ARO, CE, ME, or MFE major, C or better in MAT 116, and C- or better in ME 214.

ME 217 Mechanics for ECE Majors (4)

A basic course in statics and dynamics for ECE majors. Selected topics from ME 214 and ME 215 specific to electrical engineering. 4 lectures/problem-solving. Prerequisites: C– or better in PHY 131 and C or better in MAT 115.

ME 218 Strength of Materials I (3)

Plane stress and strain. Principal stresses and strains, Mohr's Circle. Properties of materials, stress strain diagrams. Generalized Hooke's Law for isotopic materials. Design loads, working stresses, and factor of safety. Statically indeterminate 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. 3 lectures/problem-solving. Prerequisite: CE, IE, ME, or MFE major or MTE minor, and C– or better in ME 214.

ME 219 Strength of Materials II (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. 3 lectures/problem-solving. Prerequisites: C– or better in ME 218 and ME 224L.

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: ME major or MTE minor, ENG 105 or PHL 202 or ME 231, and passing grade in GWT.

ME 224L Mechanics 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. Prerequisite: ARO, CHE, CE, IE, ME, or MFE major.

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 lectures/problem-solving. Prerequisite: ENG 104 or equivalent.

ME 232 Engineering Digital Computations (2)

Simple math problems involving basic computational methods including elementary concepts of digital computer programming. Proficiency will be gained in writing computer programs. Assignments include the use of the computer facilities. 2 lectures/problem-solving. Corequisite: ENG 104 or equivalent. Prerequisite: C or better in MAT 114.

ME 232A Engineering Digital Computations Projects (1)

Engineering problems/projects involving basic computational methods including elementary concepts of digital computer programming. Proficiency will be gained in writing computer programs. Assignments include the use of the computer facilities. 1 unit activity/problem-solving. Prerequisite: C- or better in ME 232.

ME 233/L 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, and electric motors. Introduction to shaft design, bearings and attachments. The execution of layouts and engineering specifications for manufacture. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: MFE 126/L, and C– or better in ME 100L, ME 214 and ME 224L.

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

Study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, of which 3 may be used in the technical elective package. Maximum of 4 units per quarter. Instruction is by lecture, laboratory, or a combination.

ME 301 Thermodynamics I (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; carnot cycle, simple Brayton cycle, 4 lectures/problem-solving. Prerequisite: CE, ME, or MFE major, and C– or better in ME 214.

ME 302 Thermodynamics II (4)

Rankine cycle and its variations; refrigeration cycles; advanced Brayton cycle and Otto and Diesel cycles; mixtures of ideal gases; Maxwell relations; chemical thermodynamics. 4 lectures/problem-solving. Prerequisite: C– or better in ME 301.

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 lectures/problem-solving. Prerequisite: C– or better in ME 301.

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 lectures/problem-solving. Prerequisite: C– or better in ME 301.

ME 311 Fluid Mechanics I (3)

Analysis of 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, and fluid measurement. 3 lectures/problem-solving. Prerequisites: CE, ME, or MFE major, C or better in MAT 214, and C- or better in ME 215.

ME 312 Fluid Mechanics II (3)

Similarity and dimensional analysis; steady closed conduit flow in pipes and pump/pipe networks; flow of real compressible fluids; from boundary layers, and drag. 3 lectures/problem-solving, Prerequisites: C– or better in ME 301 and ME 311.

ME 313L Fluid Mechanics Laboratory (1)

Measurement of viscosity of fluids, centrifugal pump and/or fan performance, pressure drop in pipes, fluid rate meters, jet momentum and air velocity distribution in ducts. Calibration and use of laboratory equipment; design of a basic fluid mechanics experiment; acquisition, processing, and analysis of data by manual and automated methods; report writing. 1 three-hour laboratory. Corequisite: ME 312. Prerequisites: ENG 105 or PHL 202 or ME 231, and passing grade in GWT.

ME 315 Engineering Materials (4)

A study of the relationship among structure, processing and properties of engineering materials. Strengthening mechanisms for ferrous and non-ferrous metals and the application of such materials in engineering situations. Phase diagrams and their relevance to the structure, processing and properties of metallic alloys. Mechanical behavior of polymers, ceramics and composites and their applications in engineering practice. Corrosion and degradation of materials. 4 lectures/problem solving. Prerequisites: CHM 122 and C– or better in ME 218.

ME 316 Intermediate Dynamics (3)

Three-dimensional particle and rigid body dynamics, motion relative to rotating reference frames, moments and products of inertia, momentum and energy principles, gyroscopic motion. 3 lectures/problem-solving. Prerequisites: C– or better in ME 215 and C or better in either MAT 216 or MAT 224.

ME 319 Stress Analysis (4)

Thin and thick-walled pressure vessels, shrink fit, contact stresses, Castigliano's theorem, and other special topics. Failure theories, stress concentration, steady and repeated loading. fatigue and endurance strength, shaft design and analysis, fastener and spring analysis. 4 lectures/problem-solving. Prerequisites: C– or better in ME 219, ME 220L and ME 233/L.

ME 325/L 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: MFE 201/L, C– or better in ME 215, and ME 319.

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 lectures/problem-solving. Prerequisites: C or better in either MAT 216 or MAT 224, and C– or better in ME 232 or equivalent.

ME 340 Modeling and Simulation of Dynamic Systems (3)

Analysis and synthesis of steady-state and transient engineering problems associated with mechanical engineering. Emphasis is placed upon formulating the differential of fundamental equations from basic assumptions and applying various methods of solution. Computer simulations. 3 lecture/problem-solving. Prerequisites: ECE 231/L, C or better in either MAT 216 or MAT 224. Corequisites: ME 232/232A, ME 301, and ME 311.

ME 350L Engineering Materials and Selection Laboratory (1)

Laboratory tests of brittle fracture cold working, annealing, heat treatment, and mechanical properties of materials. Material selection for prescribed applications. 1 three-hour laboratory. Prerequisites: C- or better in ME 315, C- or better in ENG 105 or ME 231 or PHL 202, and passing grade in GWT.

ME 400 Special Study 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 405 Acoustics and Noise Control (4)

Fundamental acoustic parameters (dB, dBA, PSIL, octave band). Physiological response to noise, noise standards, sound pressure-power relation, and 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 lectures/problem-solving. Prerequisites: C– or better in ME 301, ME 311, C or better in MAT 215 and either MAT 216 or MAT 224.

ME 406/A Finite Element Analysis (3/1)

Stiffness and influence coefficients, shape functions, element stiffness, coordinate transformations, and assembling of 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. 3 lectures/problem-solving and 1 two-hour activity. Prerequisites: C– or better in ME 219, and ME 330 or ME 340.

ME 407/L 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: C– or better in ME 301 and ME 415.

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 lectures/problem-solving. Prerequisites: C or better in either MAT 216 or MAT 224, C- or better in PHY 133 and , and C– or better in ME 301.

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 lectures/problem-solving. Prerequisites: C– or better in ME 301 and ME 311.

ME 411/L 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: C– or better in ME 302 and ME 311.

ME 412/L 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: C– or better in ME 302.

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 multiple degree of freedom systems, flexibility and stiffness coefficients, transfer matrices, computational methods. 4 lectures/problem-solving. Prerequisite: C– or better in ME 340.

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 internal flows. Heat exchangers. Basic laws of radiation heat transfer, radiation properties of surfaces and radiant energy exchange among simple surfaces. 4 lectures/problem-solving. Prerequisites: C or better in either MAT 216 or MAT 224, C- or better in ME 301 and ME 311.

ME 417/L Building Energy Calculations/Laboratory (3/1)

Thermodynamic processes in buildings; thermal environmental requirements for human habitation; calculation of building heating and cooling loads; predicting building energy use. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: C– or better in ME 302 and ME 311.

ME 418/L Air Conditioning/Laboratory (3/1)

Psychometrics; comfort and health room air distribution; building air distribution systems; principles of refrigeration; refrigeration equipment; heating equipment; air conditioning system types. 3 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: C– or better in ME 302, ME 312 and ME 415.

ME 421 Dynamics of Machinery (4)

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. 4 lectures/problem-solving. Prerequisite: C– or better in ME 215.

ME 425/L Advanced Machine Design/Laboratory (3/1)

The emphasis of this course is placed on the actual process of modern 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 lectures/problem-solving and 1 three-hour laboratory. Prerequisite: C– or better in ME 325/L.

ME 427 Thermal Systems Design (4)

Piping networks, sizing and design of a pipe system, fluid transients, rotary pump design and selection, heat exchanger design, thermal system simulation using computer-aided analytical techniques. Preliminary design and preparation of specifications for procurement of thermal fluid mechanical equipment to meet performance requirements. 4 lectures/problem-solving. Prerequisites: C– or better in ME 312 and ME 415. Corequisite: ME 302.

ME 435/L Theory and Design for Mechanical Measurement/Laboratory (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 lectures/problem-solving and 1 three-hour laboratory. Prerequisites: C– or better in ME 340, ME 313L, and ME 415.

ME 439/L Control of Mechanical Systems/Laboratory (3/1)

Design and comparison of hydraulic, pneumatic and electrical control systems. Pneumatic, hydraulic and electrical control circuit theory and design. The design and programming of control circuits using microprocessors. Introduction to Programmable Logic Controllers. Application of control systems in thermal, mechanical and mechatronic systems. 3 lectures/problem solving and 1 three-hour laboratory. Prerequisites: C- or better in ME 340 and ME 325/L.

ME 460 Team Senior Design Project (4)

Design, fabrication and testing of a project(s) selected by and under supervision of a faculty member. Students work in small groups. Project results are presented through periodic written and/or oral progress reports and a written formal final report. 4 lecture discussions. Prerequisites: C- or better in ME 301, ME 302, ME 311, ME 312, ME 313L, ME 315, ME 316, ME 319, ME 340, and ME 350L.

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. Prerequisites: Successful completion of all lower division GE courses, C- or better in ME 301, ME 311, ME 312, ME 313L, ME 315, ME 319, ME 330A, ME 340, and D- or better in ME 302, ME 316, ME 325/325L, and ME 350L.

ME 463 Undergraduate Seminar (2)

New developments, policies, practices, procedures and ethics in mechanical engineering. Each student is responsible for the preparation of a technical report or senior project proposal and the development and oral presentation of a topic in the field of mechanical engineering. 2 lectures/seminars. Prerequisites: satisfaction of the GWT requirement and C- or better in ME 302, ME 312, and ME 315.

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. Instruction is by lecture, laboratory, or a combination.