College of Engineering

ACADEMIC PROGRAMS

Aerospace Engineering ....................................... BS*, MS
BioResource & Agricultural Engineering ... BS*
   (College of Agriculture)
Civil and Environmental Engineering .......... MS
Civil Engineering ........................................ BS*
Computer Engineering ................................ BS*
Computer Science ........................................ BS**, MS,
   Minor
Electrical Engineering ................................... BS*, MS
Engineering ................................................. MS
Engineering Management ............................. MBA/MS
Environmental Engineering ......................... BS*
General Engineering .................................... BS
Industrial Engineering ................................. BS*, MS
Manufacturing Engineering ......................... BS*
Materials Engineering ................................ BS*
Mechanical Engineering ............................... BS*, MS
Multidisciplinary Design ......................... Minor
Software Engineering .................................. BS
Transportation Planning ............................... MCRP/MS

* Engineering programs accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – telephone: (410) 347-7700.

** BS Computer Science program accredited by the Computing Accreditation Commission of the Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – telephone: (410) 347-7700.

Engineering and computer science programs at Cal Poly prepare graduates for practice in professional engineering and computer science. Attributes of engineering graduates include:

(a) an ability to apply knowledge of mathematics, science, and engineering;
(b) an ability to design and conduct experiments, as well as to analyze and interpret data;
(c) an ability to design a system, component, or process to meet desired needs;
(d) an ability to function on multi-disciplinary teams;
(e) an ability to identify, formulate, and solve engineering problems;
(f) an understanding of professional and ethical responsibility;
(g) an ability to communicate effectively;
(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context;
(i) a recognition of the need for, and an ability to engage in life-long learning;
(j) a knowledge of contemporary issues; and
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

2003-2005 Cal Poly Catalog
Our curricula reflects a "learn by doing" philosophy via incorporation of numerous design-centered laboratories, integration of design, and inclusion of the senior design project capstone design experience.

The excellence of Cal Poly's undergraduate engineering and computer science programs provides the foundation for master's degree programs. Industry often considers the master's degree as an important requirement for the design, development, applied research and analysis occupations in engineering and computer science. The master's degree allows entry into these occupations at higher levels of technical skills and responsibilities.

ENVIRONMENTAL STUDIES MINOR
Please see the College of Science and Mathematics for more information on this interdisciplinary minor.

STUDENT SERVICES CENTER
The College of Engineering Student Services Center, located in the Engineering South Building (40), houses the Advising Center, the MESA Engineering Program, and the Women’s Engineering Program. These offices provide centralized services to undergraduate engineering students.

Advising Center
Stacey Breitenbach, Director
Engineering South (40), Room 115
(805) 756-1461
www.ee.calpoly.edu/CENGAC/

The College of Engineering Advising Center provides academic advising services to all majors within the college in conjunction with each student's faculty advisor. The Advising Center is open five days a week, nine hours per day during the quarter.

The center tracks the academic and administrative progress of all engineering students. Current academic and administrative probation policies are posted on our web site, as well as other information that pertains to new and continuing students. Students should be aware that all full-time engineering students are expected to complete (with passing grades) a minimum of two major and/or support courses per quarter with no more than one course per quarter that does not count toward their stated degree.

Most student-related forms (such as curriculum substitution and change of major) are processed in the Advising Center. The majority of the general education questions and interpretation of transfer credit questions are handled in the Advising Center after the Evaluations Office has provided the initial evaluation.

The Advising Center maintains working folders on each student. These folders are used for general advising purposes. The Advising Center has past and present flowcharts and curriculum sheets for all engineering majors, major specific technical elective forms, FE (EIT) information packets, articulation agreements, and engineering-related pamphlets for student perusal.

While the Advising Center is responsible for providing procedural advice, faculty advisors are responsible for providing academic content and technical advice. Student course scheduling, course content questions, and career planning are usually done by the faculty advisors. Depending on the form and the student's major, the director of the Advising Center has signature authority to sign for the advisor, department chair, and associate dean with strict adherence to procedures developed with the department heads/chairs and the dean and associate deans.

MESA Engineering Program (MEP)
David Cantu, Director
Engineering South (40), Room 117
(805) 756-1433
www.calpoly.edu/~mep

The MESA Engineering Program (MEP) is an academic support program designed to recruit, retain, and graduate educationally disadvantaged students in engineering and computer science disciplines. MEP builds an academic support community among students and provides the necessary bridges for students' academic and professional success.

MEP offers an orientation class in effective learning techniques. A study center is available for students so that they can overcome feelings of isolation, develop supportive academic peer groups, and share information about classes and scholarship opportunities. Tutoring is available for undergraduate technical courses. Group study workshops teach students complex technical concepts through group study and support. MEP fosters professional development by helping coordinate summer jobs, internship, and scholarship opportunities with companies who recognize the MEP as a valuable source for skilled future employees.

Women’s Engineering Program (WEP)
Helene Finger, Director
Engineering South (40), Room 119
(805) 756-2350
http://ceng-web.calpoly.edu/wep.php

The mission of the Women’s Engineering Program (WEP) is to recruit and retain women engineering and computer science students by focusing on outreach, on-campus support and professional preparation objectives. To meet these objectives, WEP works closely with the Society of Women Engineers (SWE) Cal Poly student section, one of the top student sections in the nation, in supporting a variety of programs directed at pre-college, undergraduate and graduate students.

Outreach activities are directed at students from kindergarten through community college. These programs are designed to encourage pre-university women and girls
to consider engineering as a career choice. Outreach recruitment activities include: Building an Engineer workshops, Shadow an Engineering Student day, Engineering Road Show, Girl Scout Engineering Badge day, elementary school workshops, and career fairs.

The Women’s Engineering Program provides on-campus support to Cal Poly women engineering students through a variety of academic, leadership and social activities. These activities help students connect to their peers while concurrently assisting them in achieving their educational goals. On-campus support activities include: scholarships, academic counseling and referrals, pre-registration counseling, big sibling program, test files, teacher evaluations, SWE meetings, and community service activities.

Professional preparation activities are designed to prepare students for a productive career by facilitating networking with professionals and corporations. Professional preparation activities include: Shadow an Engineer, Evening With Industry banquet, Team Tech, Industry Tours, Resume Book, and MentorNet.
Master of Science in Engineering

PROGRAMS

MS Engineering with Specializations in:
- Biochemical Engineering
- Bioengineering
- Biomedical Engineering
- Integrated Technology Management
- Materials Engineering
- Water Engineering

Blended BS+MS Programs

Joint Programs:
- Engineering Management Specialization, MBA/MS Engineering
- Transportation Planning Specialization, MCRP/MS Engineering

MS Engineering

General Characteristics

The Master of Science degree program in Engineering has the following objectives:

- Provide preparation for further study in engineering, leading to the Doctor of Engineering or Ph.D. degree.
- Provide an empowering terminal professional degree for students who intend to become practicing engineers, a degree that not only retains the strong laboratory emphasis and industrial interaction found in the BS curriculum, but which also provides an attractive, efficient educational option to undergraduate students.
- Provide job-entry education for the more complex and evolving interdisciplinary areas of engineering, such as research and development, innovative design, systems analysis and design, bio-engineering, biomedical engineering, manufacturing, mechatronics, and engineering management.
- Update and upgrade opportunities for practicing engineers.
- Allows graduates to maintain currency in their fields.

Prerequisites

For admission as a classified graduate student, an applicant should hold a bachelor’s degree in engineering or a closely related physical science with a minimum grade point average of 2.5 in the last 90 quarter units (60 semester units) attempted. Applicants for graduate engineering programs are required to submit scores for the General Test of the Graduate Record Examination. An applicant who meets these standards but lacks prerequisite coursework may be admitted as a conditionally classified student and must make up any deficiencies before advancement to classified graduate standing.

Program of Study

Graduate students must file formal study plans with their advisor, department, college, and university graduate studies office no later than the end of the quarter in which the 12th unit of approved courses is completed.

The formal program of study must include a minimum of 45 units (at least 23 of which must be at the 500 level) with a specialization in one of the following areas: Biochemical Engineering, Bioengineering, Biomedical Engineering, Industrial Engineering, Integrated Technology Management, Materials Engineering, or Water Engineering.

Requirements

The broad curriculum requirements for the Master of Science degree in Engineering are:

a) a minimum of 24 units in the field of specialization, with at least 18 units at the 500 level;

b) a minimum of 9 units from an approved list of mathematics, statistics, computer science, or analytic engineering courses, with at least 3 units at the 500 level;

c) remaining units taken from a list of approved electives;

d) at least 23 units of the 45 unit program at the 500 level.

In some specializations, two program options are available: a thesis program which requires coursework, a thesis and oral defense of thesis; or a non-thesis option which involves additional coursework and a comprehensive examination. The non-thesis option is normally allowed only for those students who have completed a senior project or have had significant engineering project experience.

Joint Programs

The College of Engineering offers two joint programs: in conjunction with the Orfalea College of Business, the MBA/MS Engineering, with a specialization in Engineering Management; and with the College of Architecture and Environmental Design (City and Regional Planning Department), the MCRP/MS Engineering, with a specialization in Transportation Planning.

Other Graduate Engineering Programs

In addition to the MS in Engineering, the college also offers several other graduate programs: MS Aerospace Engineering, MS Civil and Environmental Engineering, MS Computer Science, MS Electrical Engineering, MS Industrial Engineering, and MS Mechanical Engineering. Information regarding these programs is listed with the respective department.
Blended BS + MS Engineering Program
The blended program provides motivated students with an accelerated route to the MS Engineering, with simultaneous conferring of both bachelor's and master's degrees. Students in the blended program are provided with a seamless process whereby they can progress from undergraduate to graduate status.

Eligibility for Blended BS+MS Engineering
Students majoring in BS General Engineering, BS Computer Engineering, BS Manufacturing Engineering, and BS Materials Engineering may be eligible to pursue the blended program toward the MS Engineering with a specialization in Biochemical Engineering, Bioengineering, Biomedical Engineering, or Integrated Technology Management. They may also be able to pursue blended programs incorporating MS degrees from other departments in the College of Engineering.

In addition, students in departments with their own masters degrees may be able to pursue masters degrees in other departments, or the MS Engineering degree via the 4+1 program, based on agreements between their bachelors granting program and their target masters program.

Participation in the program is based on prior academic performance and other measures of professional promise. Students are selected by an interdisciplinary faculty committee, chosen on the basis of the student’s area of interest. Please see page 96 for eligibility criteria.

Program of Study
The program allows students to complete a more meaningful capstone experience that integrates the senior project with the graduate thesis. This arrangement also increases the possibilities for industrial interaction in the students' professional program.

The blended program allows students to earn graduate credit for several of their senior electives, effectively decreasing the summed unit requirements for both degrees in the most efficient manner.

Other Blended Programs
Blended BS+MS programs are also available in Aerospace Engineering, Civil and Environmental Engineering, Computer Science, Electrical Engineering, Industrial Engineering, and Mechanical Engineering. Additional information may be obtained from the specific department or from the College of Engineering.

Example Curriculum for General Engineering student in Blended Program
In this example, a student chose to focus on biomaterials aspects of the field.

<table>
<thead>
<tr>
<th>1st Year</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>Winter</td>
<td>Spring</td>
</tr>
<tr>
<td>ENGR 110</td>
<td>ENGR 111</td>
<td>ENGR 112</td>
</tr>
<tr>
<td>CHEM 124</td>
<td>CHEM 125</td>
<td>Life sc</td>
</tr>
<tr>
<td>Area A ge</td>
<td>Area A ge</td>
<td>Area A ge</td>
</tr>
<tr>
<td>MATH 141</td>
<td>MATH 142</td>
<td>MATH 143</td>
</tr>
<tr>
<td>PHYS 131</td>
<td>PHYS 132</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2nd Year</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>Winter</td>
<td>Spring</td>
</tr>
<tr>
<td>EE 201</td>
<td>CE 204</td>
<td>MATE 210</td>
</tr>
<tr>
<td>ME 211</td>
<td>ME 212</td>
<td>MATE 215</td>
</tr>
<tr>
<td>Area D ge</td>
<td>Area D ge</td>
<td></td>
</tr>
<tr>
<td>MATH 241</td>
<td>MATH 244</td>
<td>STAT 350*</td>
</tr>
<tr>
<td>PHYS 133</td>
<td>CHEM 305*</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3rd Year</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>Winter</td>
<td>Spring</td>
</tr>
<tr>
<td>ME 302</td>
<td>ME 313</td>
<td>ME 341</td>
</tr>
<tr>
<td>IME 314</td>
<td>ME 328</td>
<td>MATE 424</td>
</tr>
<tr>
<td>MATE 230</td>
<td>CHEM 328</td>
<td>CSC 342</td>
</tr>
<tr>
<td>CHEM 326</td>
<td>Area C ge</td>
<td>Area C ge</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4th Year</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>Winter</td>
<td>Spring</td>
</tr>
<tr>
<td>MATE 440</td>
<td>CSC 480</td>
<td>IME 319</td>
</tr>
<tr>
<td>MATE 425</td>
<td>ENGR 581</td>
<td>EE 321</td>
</tr>
<tr>
<td>CSC 103</td>
<td>Area C ge</td>
<td>MATE 570</td>
</tr>
<tr>
<td>Area D ge</td>
<td>Area C ge</td>
<td>Area D ge</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5th Year</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>Winter</td>
<td>Spring</td>
</tr>
<tr>
<td>STAT 512</td>
<td>ENGR 590</td>
<td>ENGR 591</td>
</tr>
<tr>
<td>ENGR 582</td>
<td>EE 500-level</td>
<td>MATE 400-level</td>
</tr>
<tr>
<td>MATE 530</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thesis 599*</td>
<td>Thesis 599*</td>
<td>Thesis 599*</td>
</tr>
</tbody>
</table>

Total Units = 231

<table>
<thead>
<tr>
<th>ge</th>
<th>General Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>*</td>
<td>Math &amp; Science Elective</td>
</tr>
<tr>
<td>elect</td>
<td>Elective</td>
</tr>
<tr>
<td>tech</td>
<td>Technical Elective</td>
</tr>
<tr>
<td>tech*</td>
<td>Shared BS and MS Technical Elective</td>
</tr>
</tbody>
</table>
### MS Engineering, Specialization in BIOCHEMICAL ENGINEERING

**Required Courses** ...................................................... 37  
- Analytical methods for engineering (6)  
- Advanced mathematics (3)  
- ENGR 599 Design Project (Thesis) (2) (2) (5) or  
- 9 units of approved technical electives and written comprehensive examination  

*Select 19 units from the following:*  
- ME 541 Advanced Thermodynamics (4)  
- ME 552 Conductive Heat Transfer (3)  
- ME 553 Convective Heat Transfer (3)  
- ENGR 581, 582, 583 Biochemical Engr I, II, III (4,4,4)  

**Approved Electives** .................................................. 8  

**MS Engineering, Specialization in BIOENGINEERING**

**Required Courses** ...................................................... 33  
- ENGR 550 Advanced Topics in Bioengineering (4)  
- MATE 530 Biomaterials (4)  
- ENGR 581 Biochemical Engineering I (4)  
- ENGR 599 Design Project (Thesis) (9)  

*Select 12 units from the following:*  
- BIO 431, 432, 442, 542  
- CSC 471, 473, 474, 475, 541  
- ENGR 450, 582  
- ENVE 443, 536  
- IME 502  
- MATE 425, 570  
- ME 401, 502, 551, 552, 553, 554  
- STAT 512, 542  

**Approved Engineering Electives** .................................. 12  

### MS Engineering, Specialization in BIOMEDICAL ENGINEERING

**Required Courses** ...................................................... 32  
- MATE/CHM 446 Surface Chemistry/Materials (3)  
- ENGR 450 Special Topics in Bioengineering (4)  
- ENGR 550 Advanced Topics in Bioengineering (4)  
- ENGR 599 Design Project (Thesis) (9)  

*Select 12 units from the following:*  
- CHEM 473; CHEM/BIO 475  
- CSC 471, 473, 474, 475  
- EE 419  
- ENVE 421  
- IME 437, 543  
- MATE 446, 530, 570  
- ME 401, 422, 423, 445, 502, 551  
- STAT 542  

**Approved Engineering Electives** .................................. 13  

### MS Engineering, Specialization in INTEGRATED TECHNOLOGY MANAGEMENT

The program goal is to develop "industry ready" graduates who will be integrators of engineering disciplines, industry concerns, and technology management. Many of the program courses involve actual integrated problems or opportunities from industrial organizations in a collaborative learning environment.

**Required Courses** ...................................................... 33/34  
- IME 503 Applied Stat. Analysis for Engineers (4)  
- IME 556 Technological Project Management (4)  
- IME 580 Manufacturing Systems (4)  
- IME 596 Team Project/Internship (10) or IME 599 Design Project/Thesis (9)  

*Approved electives in specialization (12)*

**Approved Engineering Electives** .................................. 8  
- 8 units of approved technical electives  

**Approved Electives** .................................................. 6  

### MS Engineering, Specialization in MATERIALS ENGINEERING

**Required Courses** ...................................................... 35  
- MATE 570 Advanced Materials (4)  
- STAT 512 Statistical Methods (4)  
- MATE 599 Design Project (Thesis) (2) (2) (5)  

*Select 18 units from the following:*  
- MATE 410 Materials Engineering (4)  
- MATE 440 Joining (5)  
- MATE 530 Biomaterials (4)  
- MATE 562 Mechanical Behavior of Materials (4)  
- MATE 580 Fracture Mechanics (3)  
- MATE 590 Densification Processing (4)  

**Approved Electives** .................................................. 10  

### MS Engineering, Specialization in WATER ENGINEERING

**Required Courses** ...................................................... 35  
- Analytical methods for engineering (6)  
- Advanced Mathematics (3)  
- ECON 410 Public Finance/Cost-Benefit Analysis (4)  
- BRAE 435/BRAE 414/BRAE 440 (3)  
- BRAE 533 Irrigation Project Design (4)  
- CE 533 Adv Water Resources Engineering (3)  
- CE 573 Public Works Administration (3)  
- BRAE/CE 599 Design Project (Thesis) (2) (2) (5) or  
- 9 units of approved technical electives and written comprehensive examination  

*Approved Elective Courses* ........................................... 10  

*Select 10 units from the following:*  
- BRAE 414, 437, 440, 492, 533  
- CE 434, 440  
- ENVE 438, 439, 535  

---

2003-2005 Cal Poly Catalog
MBA/MS Engineering, Specialization in ENGINEERING MANAGEMENT

The dual-degree Engineering Management Program (EMP) specialization is an interdisciplinary program linking the MBA and MS in Engineering degree programs. It is a cooperative effort between the College of Engineering (Industrial and Manufacturing Engineering Department) and the Orfalea College of Business. Entering students are required to have a prerequisite degree in engineering, computer science, or similar technical degree to be admitted to both the College of Engineering and the College of Business, and to be enrolled in both degree programs.

The program can be completed in 21 months. Upon completion, participants will be awarded both MBA and MS in Engineering degrees, each with a specialization in Engineering Management.

The mission of the program is to develop "industry ready" graduates who will be facilitators of change and integrators of engineering, business, and people issues.

The three major objectives are:
1) to integrate knowledge and skills from engineering and business disciplines for effective responses to rapidly changing technological and business environments;
2) to prepare engineers for effective participation in management of technology, management of technology-based organizations, and management of technological change; and
3) to take advantage of the unique background of program participants and the unique strengths of Cal Poly.

Business courses (48)
- GSB 510 The General Manager I ....................... 12
- GSB 520 The General Manager II ...................... 12
- GSB 530 The General Manager III ..................... 8
- GSB 540 The General Manager IV ..................... 8
  (includes comprehensive examination)
- Approved GSB or BUS electives selected from:
  - GSB 567, 569, 578, 587; BUS 410, 427, 446;
  - ECON 401; AGB 563 .................................. 8

Engineering courses (45)
- IME 503 Applied Statistical Analysis for Engineers 4
- IME 556 Technological Project Management .......... 4
- IME 580 Manufacturing Systems ....................... 4
- IME 596 EMP Internship/Team Project ................. 10/9
- Approved electives in specialization ................... 12
- Approved Engineering electives ....................... 11/12

Approved GSB/BUS or Engineering elective .......... 4

Formal Study Plan. The Formal Study Plan for this dual degree must be approved by both the College of Business Director of Graduate Programs and by the College of Engineering Advisor for the Engineering Management Program.

MCRP/MS Engineering, Specialization in TRANSPORTATION PLANNING

The Transportation Planning Specialization is a joint interdisciplinary program between the College of Engineering and the College of Architecture and Environmental Design. Participation in the program requires enrollment in both Colleges. Participants successfully completing the program will be awarded both the MCRP and the MS in Engineering, each with a Specialization in Transportation Planning.

The major objectives of this joint program are:

(a) To provide an interdisciplinary graduate program which combines elements of transportation planning with city and regional planning to address a need for professionals who understand the technology of transportation planning and the importance of transportation within the urban environment. The required master's project enables students to integrate their work through directed study applied to special areas of their choosing.

(b) To provide planners with courses essential to understanding the technologies of transportation planning. To provide engineers with a broad background in urban studies and a knowledge of contemporary environmental issues.

(c) To take advantage of the backgrounds of program participants. The graduate students of both sponsoring departments include mature professionals returning for advanced degrees and recent graduates with a diversity of specializations.

Prerequisites

Applicants must have satisfactorily completed courses that cover the following or equivalent subject areas:
- CE 221 Fundamentals of Transportation Engineering
- CE 381 Geotechnical Engineering or GEOL 201 Physical Geology
- CSC 231 Fortran for Engineering Students
- ECON 201 Survey of Economics
- ENGL 148 Reasoning, Argumentation and Professional Writing
- MATH 143 Calculus
- PHYS 131 General Physics
- SCOM 101 Public Speaking
- STAT 321 Probability and Statistics for Engineers and Scientists

Applicants for admission are expected to:
* Have earned a bachelor's degree from an accredited university or college,
* Have attained a grade point average of 3.0 in last 90 units of undergraduate work,
* Provide results of the Graduate Record Examination (GRE) Aptitude Test to the Admissions Committee.
* Give indications of motivation, maturity, and high
  standards of academic involvement through work and
  references (three letters required) and submission of a
  project or paper demonstrating writing ability,

* Provide a statement (maximum of 300 words) addressing
  their understanding of and areas of interest in planning,
  career objectives, and educational objectives.

Applicants lacking prerequisites or other background
requirements for classified standing may be admitted on a
conditionally classified basis, depending on the results of an
individual analysis of their applications.

**Core Courses** .............................................................. 65
CE 523 Transportation System Planning (4)
CE 528 Transportation Analysis or
   CE 525 Airport Planning and Design (4)
CE 591 Graduate Seminar (1)
CE 599 (2,2,2) or CRP 599 Project /Thesis (6)
CRP 409 Planning Internship (2)
CRP 420 Land Use Law (4)
CRP 435 Transportation Theory (3)
CRP 501 Foundations of Cities and Planning (4)
CRP 510 Planning Theory (4)
CRP 513 Planning Research Methods (4)
CRP 515 Planning Presentation and
   Communication Techniques (3)
CRP 516 Quantitative Methods in Planning (4)
CRP 518 Policy Analysis for Planners (4)
CRP 525 Plan Implementation (4)
CRP 530 Planning Agency Management (3)
CRP 552 Community Planning Laboratory (4)
CRP 553 Project Planning Laboratory (4)
CSC, MATH, STAT or other approved
   quantitative methods course (3)

**Emphasis Area (select one of the following)** ............ 10

* **Urban Land Planning Emphasis**
  CRP 520 Feasibility Studies in Planning (4)
  CRP 548 Principles of City Design (3)
  Urban Land Planning electives (3)

* **Regional and Environmental Planning Emphasis**
  CRP 404 Environmental Law (3)
  Regional and Environmental Planning electives (7)

**Approved CE/ENVE electives:** ......................... 15
Electives may include: CE 421, 422, 424, 522,
   525, 528, 529, 573, 574, ENVE 411, 465

---

2003-2005 Cal Poly Catalog
Aerospace Engineering

Department Office
Engineering Bldg. (13), Room 260
(805) 756-2562  FAX: (805) 756-2376

College of Engineering Advising Center
Engineering South (40), Room 115
(805) 756-1461

Department Chair, Daniel J. Biezad
Russell M. Cummings    Jordi Puig-Suari
Dianne J. DeTurris    Jin Tso
Faysal A. Kolkailah

ACADEMIC PROGRAMS
BS, MS Aerospace Engineering
Multidisciplinary Design Minor

The Bachelor of Science degree in Aerospace Engineering prepares students for engineering work related to aerodynamics, flight testing, structures, propulsion, control systems, vehicle dynamics, stability and control, flight simulation, and design for both fixed and rotary wing aircraft, missiles, and spacecraft. The problems faced by the aerospace industry offer an unusual engineering challenge. Much of the analysis and testing must be accomplished at the very frontiers of knowledge. Nevertheless, products must be designed and manufactured; thus, an exceptionally wide range of engineering abilities is required within the industry and government.

The Aerospace Engineering Department’s mission is to educate students using a laboratory-based, hands-on approach. This approach, coupled with a systems view of engineering, is encouraged through coursework and a group-based capstone design experience. This educational philosophy has yielded engineers capable of working in positions of technical responsibility and leadership in a modern multidisciplinary, systems-based environment.

Graduates in Aerospace Engineering will 1) be well rounded engineers for positions of technical responsibility and leadership in a modern multi-disciplinary system-oriented environment that emphasizes problem solving; 2) achieve high-quality professional performance in both aeronautical and astronautical engineering by integrating a systems view of engineering that is built upon group based design experiences; and 3) demonstrate a solid foundation in aerodynamics, controls, structures, propulsion and their integration into systems design.

Aerospace Engineering graduates obtain employment in all phases of the aerospace industry such as general design, aerodynamics, stress analysis, flight testing, flight simulation, dynamics, stability and control, and propulsion systems.

The BS degree program in Aerospace Engineering is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology. It places emphasis on both analysis and design, with supplementary basic work in laboratory projects. Throughout the entire program there is constant interplay between theory and application. Opportunities are available for advanced elective work in the student's field of special interest.

The program maintains laboratory facilities for fabrication, propulsion, structures and composites, aerodynamics, dynamics and control, flight simulation and flight test, aerothermodynamics, and design.

Aerospace students may participate in two student chapters of national professional societies—the American Institute of Aeronautics and Astronautics and the Society for the Advancement of Material and Process Engineering. There is also a student chapter of the national aerospace engineering honor society, Sigma Gamma Tau.

Blended BS + MS Aerospace Engineering

The blended program provides motivated students with an accelerated route to the MS Aerospace Engineering, with simultaneous conferring of both bachelor’s and master’s degrees. Students in the blended program are provided with a seamless process whereby they can progress from undergraduate to graduate status.

Eligibility
Students majoring in BS Aerospace Engineering may be eligible to pursue the blended program toward the MS Aerospace Engineering. Participation in the program is based on prior academic performance and other measures of professional promise, with a minimum GPA of 2.5 required (3.0 GPA recommended). Students are selected by a faculty committee. Please see page 96 for eligibility criteria.

Program of Study
The program allows students to complete a more meaningful capstone experience that integrates the senior project with the graduate thesis. This arrangement also increases opportunities for industrial interaction.

The blended program allows students to double count up to nine units of coursework to fulfill the requirements for the BS and MS degrees. For instance, five of the nine units of AERO 599 Thesis can serve to complete the senior project requirement or a graduate lecture/lab course can be used as a senior elective.

Multidisciplinary Design Minor

The minor will enhance students' ability to work in multidisciplinary engineering teams. The students will develop an understanding of the design process and the role of systems engineering in product design and development including costs analysis. They will also learn the systems integration process and how different subsystems are interfaced to develop a successful product.
Non-AERO students in the minor will be admitted by permission of the minor coordinator, and not held to the prerequisites for AERO 443/444/445 or AERO 447/448/449, nor IME 418.

Curriculum for Multidisciplinary Design Minor
Introductory courses .................. 14
  IME 314 Engineering Economics (3)
  IME 418 Product-Process Design (4)
  BUS 271 Principles of Management (3)
  PSY 350 Teamwork (4)
Core courses ................................ 16
  AERO 360 Creative Prob. Solv/Engrg Design (2)
  AERO 443/444/445 or AERO 447/448/449 (10)
  AERO 450 Aerospace Systems Engineering (4)

BS AEROSPACE ENGINEERING
For course prerequisites, please refer to the "Course Descriptions" section of this catalog. In scheduling your courses each quarter, consult with your academic advisor. * Satisfies GE requirement; see page 76.

Freshman
AERO 121 Aerodynamics Fundamentals .................. 2
CHEM 124 Gen Chem for Engineering (B3/B4)* ........ 4
IME 144 Intro Design and Manufacturing ............... 4
ENGL 134 Writing: Exposition (A1)* ................... 4
ENGL 149 Technical Writing for Engineers (A3)* .... 4
SCOM 101/102 Speech Communication (A2)* .......... 4
MATH 141, 142 Calculus I, II (B1)* .................... 4,4
MATH 143 Calculus III (Add’l Area B) .................. 4
PHYS 131 General Physics (Add’l Area B) ............. 4
PHYS 132 General Physics .................................. 4
Literature elective (C1) ..................................... 4
Self development elective (CSU Area E) (D4)* ....... 4

Sophomore
AERO 215 Introduction to Aerospace Design .......... 2
AERO 300 Aerodynamics Analysis ...................... 5
BIO 213 and ENGR/BRAE 213 (B2)* ................... 2,2
CE 204 Strength of Materials ................................ 3
CE 205, 206 Strength of Materials and Lab .......... 2,1
EE 201, 251 Electric Circuit Theory and Lab ........ 3,1
ME 211 Engineering Statics .................................. 3
ME 212 Engineering Dynamics ............................ 3
MATH 241 Calculus IV ........................................ 4
MATH 244 Linear Analysis I ............................... 4
PHYS 133 General Physics ...................................... 4
STAT 312 Statistical Methods for Engineers (B6)* .... 4
Fine and performing arts elective (C3)* ................ 4
American experience elective (D1) ....................... 4

Junior
AERO 301, 302 Aerodynamics Fundamentals ............ 5,5
AERO 303, 304 Aerodynamics Fundamentals .......... 5,2
AERO 306 Aerodynamics and Flight Performance .... 4
AERO 307 Experimental Aerodynamics .................. 2
AERO 320 Fundamentals of Guidance and Control ... 4
AERO 331 Aerospace Structural Analysis I .......... 5

EE 321, 361 Electronics and Lab .......................... 3,1
MATE 210 Materials Engineering ....................... 3
Political economy elective (D2) ......................... 4
Comparative social institutions elective (D3) ......... 4

Senior
AERO 401 Propulsion Systems ................................ 4
AERO 420 Stability/Control of Aerospace Vehicles .. 4
AERO 431 Aerospace Structural Analysis II .......... 3
AERO 433 Aerospace Experimental Stress Analysis . 1
AERO 461, 462 Senior Project or
  AERO 463, 464 Senior Project Laboratory .......... 2,3
Philosophy elective (C2) ................................... 4
Literature, philosophy, arts (300–400 level) (C4)* .... 4
Courses to complete concentration ..................... 22

BS AEROSPACE ENGINEERING
☐ 60 units upper division ☐ GWR
☐ 2.0 GPA ☐ USCP
* = Satisfies General Education requirement

MAJOR COURSES
AERO 121 Aerodynamics Fundamentals .................. 2
AERO 215 Introduction to Aerospace Design .......... 2
AERO 300 Aerodynamics Analysis ...................... 5
AERO 301, 302 Aerodynamics Fundamentals .......... 5,5
AERO 303, 304 Aerodynamics Fundamentals .......... 5,2
AERO 306 Aerodynamics and Flight Performance .... 4
AERO 307 Experimental Aerodynamics ................. 2
AERO 320 Fundamentals of Guidance and Control .. 4
AERO 331 Aerospace Structural Analysis I ........... 5
AERO 401 Propulsion Systems ............................. 4
AERO 420 Stability/Control of Aerospace Vehicles .. 4
AERO 431 Aerospace Structural Analysis II .......... 3
AERO 433 Aerospace Experimental Stress Analysis . 1
AERO 461, 462 Senior Project or
  AERO 463, 464 Senior Project Laboratory .......... 2,3
CE 204 Strength of Materials ............................ 3
CE 205, 206 Strength of Materials and Lab .......... 2,1
EE 201, 251 Electric Circuit Theory and Lab ........ 3,1
Concentration courses (see below) ..................... 22

SUPPORT COURSES
BIO 213 and ENGR/BRAE 213 (B2)* ................... 2,2
CHEM 124 Gen Chem for Engineering (B3/B4)* . 4
EE 321, 361 Electronics and Lab .......................... 3,1
ENGL 134 Writing: Exposition (A1)* ................. 4
IME 144 Intro Design and Manufacturing ............. 4
IME 314 Design and Manufacturing .................... 4
MATE 210 Materials Engineering ....................... 3
MATH 141, 142 Calculus I, II (B1)* .................... 4,4
MATH 143 Calculus III (Add’l Area B) ................. 4
MATH 241 Calculus IV ........................................ 4
MATH 244 Linear Analysis I .................................. 4
ME 211 Engineering Statics ............................... 3
ME 212 Engineering Dynamics ............................ 3

2003-2005 Cal Poly Catalog
PHYS 131 General Physics (Add’l Area B)* ....... 4
PHYS 132, 133 General Physics .......................... 4,4
STAT 312 Statistical Methods for Engineers (B6)* 4

**GENERAL EDUCATION (GE)**
72 units required; 32 units are in Support.
→See page 76 for complete GE course listing.
→Minimum of 8 units required at the 300-400 level.

**Area A Communication (8 units)**
- A1 Expository Writing ........................................ 4
- A2 Oral Communication ....................................... 4
- A3 Reasoning, Argumentation, and Writing * 4 units in Support ........................................... 0

**Area B Science and Mathematics (no add’l units req’d)**
- B1 Mathematics/Statistics * 8 units in Support....... 0
- B2 Life Science * 4 units in Support ................... 0
- B3 Physical Science * 4 units in Support .......... 0
- B4 One lab taken with either a B2 or B3 course
- B5 (requirement for Liberal Arts students only)
- B6 Upper-division Area B * 4 units in Support .... 0
Additional Area B units * 8 units in Support ........... 0

**Area C Arts and Humanities (16 units)**
- C1 Literature .................................................... 4
- C2 Philosophy .................................................... 4
- C3 Fine/Performing Arts ..................................... 4
- C4 Upper-division elective .................................. 4

**Area D/E Society and the Individual (16 units)**
- D1 The American Experience (40404) ............. 4
- D2 Political Economy ........................................... 4
- D3 Comparative Social Institutions .................. 4
- D4 Self Development (CSU Area E) ................. 4

**ELECTIVES.......................................................... 0
**
**195**

**CONCENTRATIONS (select one)**

**Aeronautics Concentration**
AERO 405 Supersonic/Hypersonic Aerodynamics.... 4
AERO 443, 444, 445 Aircraft Design .................... 2,4,4
Aeronautics electives ...................................... 8

**Astronautics Concentration**
AERO 451 Orbital Mechanics I .......................... 4
AERO 447, 448, 449 Spacecraft Design ............... 2,4,4
Astronautics electives ...................................... 8

**MS AEROSPACE ENGINEERING**

**General Characteristics.** The Master of Science program in Aerospace Engineering prepares the student for entry into a well-established field of aerospace engineering. The subject matter relative to flight simulation and controls, structures, propulsion, and aerothermal sciences has been integrated into coursework. The program emphasizes engineering science and research activity. Graduates have an increased capability for complex research, development, and innovative design, and are prepared for further study in engineering, leading to the Doctor of Engineering or Ph.D.

**Prerequisites.** For admission as a classified graduate student, an applicant must hold a bachelor's degree in engineering (preferably aerospace engineering) or a closely related physical science with a minimum grade point average of 3.0 in the last 90 quarter units (60 semester units) attempted. Applicants are required to submit satisfactory scores for the General (Aptitude) Test of the Graduate Record Examination.

An applicant who meets these standards but lacks prerequisite coursework may be admitted as a conditionally classified student and must make up any deficiencies before advancement to classified graduate standing.

Information pertaining to specific requirements for admission to graduate standing (classified or conditionally classified) may be obtained from the Graduate Coordinator, Department of Aerospace Engineering.

**Program of Study.** Graduate students must file a formal study plan with their advisor, department, college and graduate studies office by no later than the end of the quarter in which the 12th unit of approved courses is completed. The formal program of study must include a minimum of 45 units (at least 24 of which must be at the 500 level). A thesis or project is required as a culminating experience.

The Department also offers the same MS degree program to Air Force officers and engineers at Vandenberg Air Force Base (VAFB), about 60 miles south of Cal Poly. This off-campus site has the same curriculum and faculty as the main campus. During the fall, winter, and spring quarters, courses will be offered via video teleconferencing and during the summer quarter via on-site teaching. Courses will typically be offered between 4-8 p.m. to accommodate the students' working schedules.

**Required Courses.................................................. 29**

Select four of the following five options:
- AERO 520 Appl Airplane Aerodynamics (4) or AERO 521 Missle/Launch Vehicle Aerodyn (4)
- AERO 535 Adv Aerospace Structural Anly (4) or AERO 534 Aero Structural Dynamics Anly (4)
- AERO 540 Elements of Rocket Propulsion (4) or AERO 541 Air Breathing Propulsion (4)
- AERO 550 Anly/Design Flight Control Sys (4) or AERO 560 Spacecraft Dynamics and Control (4)
- AERO 515 Continuum Mechanics (4) or MATH 501 Applied Mathematics I (4)
AERO 599 Thesis (Design Project) (3) (3) (3)

**Math or numerical methods elective........................................... 4**

Advisor approved electives...................................... 12

**45**
Civil and Environmental Engineering

Department Office
Engineering Bldg. (13), Room 263
(805) 756-2947
http://ceenve.calpoly.edu
e-mail: ceenve.calpoly.edu

College of Engineering Advising Center
Engineering South (40), Room 115
(805) 756-1461

Department Chair, Alypios E. Chatziioanou
Harold M. Cota
Jay S. DeNatale
Gregg L. Fiegel
Rakesh K. Goel
Garrett J. Hall
Stephen L. M. Hockaday
Damian I. Kachlakev
Eric P. Kasper
Robert J. Lang
Kurt C. K. Lo
H. Mallareddy
Sara Moazzami
Yarrow M. Nelson
Nirupam Pal
Jeffrey G. Szczesowski
S. Somayaji
Edward C. Sullivan
Samuel A. Vigil

ACADEMIC PROGRAMS
BS Civil Engineering
BS Environmental Engineering
MS Civil and Environmental Engineering

BS Civil Engineering
The Board of Directors of the American Society of Civil Engineers has defined Civil Engineering as "...the profession in which a knowledge of the mathematical and physical sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the progressive well-being of mankind in creating, improving and protecting the environment, in providing facilities for community living, industry and transportation, and in providing structures for the use of mankind."

The Bachelor of Science degree in Civil Engineering emphasizes the application of scientific knowledge and technology for the betterment of humankind. The program stresses the team design concept and systems approach to problem solving and is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology.

Students learn to solve practical engineering problems and design civil engineering facilities and systems using traditional and state-of-the-art techniques. Extensive experience is gained through the use of modern, well-equipped laboratories. The program focuses on the preparation of graduates for immediate entry into the profession; however, adequate scientific depth is maintained throughout the curriculum so that graduates are readily accepted into graduate programs in civil engineering.

The main focus of the program is to prepare graduates for practice in professional engineering. Thus, Cal Poly's "learn by doing" philosophy is emphasized by integrating design throughout the curriculum, especially in the numerous design-centered laboratories. In the required senior project, which is completed in a two-quarter set of capstone courses, students demonstrate their understanding of engineering knowledge and their ability to apply that knowledge creatively to practical problems.

The Civil Engineering program’s educational objectives are that its graduates are able to:

a. Solve civil engineering problems using techniques of theoretical analysis, results from laboratory and field experiments, and principles of engineering design.

b. Use effective communication and teamwork skills, and appreciate the value of liberal arts and social sciences.

c. Be ethically responsible and aware of environmental and other contemporary issues in the civil engineering profession.

d. Continue life-long learning.

e. Pursue advanced studies in civil engineering.

Various program constituencies are consulted periodically for input on the appropriateness as well as the attainment of the educational objectives. Other indicators such as student/alumni placement and success rates in various tests are also used to evaluate attainment.

Graduates of the program accept a wide variety of positions in local, state and federal government service or with private engineering firms. Typically, graduates are immediately involved in the planning, design, and construction of civil engineering projects.

The Civil Engineering curriculum includes broad coverage of the engineering sciences and basic sciences, mathematics, social sciences, and humanities. Essential training is given in each of the principal civil engineering emphasis areas: environmental engineering, geotechnical engineering, structural engineering, transportation engineering, and water resources engineering. Flexibility within the curriculum allows students to take 28 units of upper division civil engineering technical electives. A student may choose to use these technical elective units to study topics related to one or more of the five principal civil engineering emphasis areas listed above. Suggested emphasis area curricula are available from the department.

In lieu of choosing a particular emphasis area, students have the opportunity to design a curriculum of their own, allowing for a broad range of civil engineering interests.
The Society of Civil Engineers (SCE) student organization is recognized as one of the nation’s premiere student chapters. The organization sponsors a variety of opportunities for professional development, community service, and social activities to supplement the formal academic program. SCE is made up of chartered student chapters of the following professional organizations: the American Public Works Association, the American Society of Civil Engineers, and the Institute of Transportation Engineers.

**BS Environmental Engineering**

The Bachelor of Science degree program in Environmental Engineering is concerned with the interrelation of people, materials, and processes in a complex and changing environment. The broad field of environmental engineering includes control of air and water pollution, industrial hygiene, environmental health and safety, solid waste, hazardous waste management, and pollution prevention. Cal Poly has one of the few undergraduate programs in this field.

The program offers a sound background in the fundamentals of thermodynamics, fluid mechanics, mass transfer, water resources and geotechnical engineering. The problem-oriented approach to instruction, in modern well-equipped laboratories, provides an excellent opportunity to gain understanding and experience. The program is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology.

The main focus of the program is to prepare graduates for practice in professional engineering. Thus, Cal Poly's "learn by doing" philosophy is emphasized by integrating design throughout the curriculum, especially in the numerous design-centered laboratories. In the required senior design project, which is completed in a two-quarter set of capstone courses, students demonstrate their understanding of engineering knowledge and their ability to apply that knowledge creatively to practical problems.

The Environmental Engineering program educational objectives are that its graduates will:

- Practice as professional engineers by gaining a thorough foundation in the following areas: (a) water and waste water, (b) air pollution, and (c) solid and hazardous wastes.
- Pursue higher studies, research and life-long learning, and develop an appreciation of liberal arts and social sciences.
- Have a global awareness of environmental issues and use appropriate technologies to solve them.

Various program constituencies are consulted periodically for input on the appropriateness as well as the attainment of the educational objectives. Other indicators such as student/alumni placement and success rates in various tests are also used to evaluate attainment.

The Society of Environmental Engineers offers technical programs and other activities, including field trips each year to study typical installations of systems. Student memberships also are available in the Air and Waste Management Association, the California Water Pollution Control Association, and the Water Environment Federation.

An engineering approach to the subject enables graduates to pursue careers in industry, consulting firms, and public agencies concerned with air and water pollution control, groundwater, potable water treatment, solid waste management, and hazardous waste management.

**Blended BS + MS Civil and Environmental Engineering**

The blended program provides motivated students with an accelerated route to an MS in Civil and Environmental Engineering, with simultaneous conferring of both bachelor’s and master’s degrees. Students in the blended program are provided with a seamless process whereby they can progress from undergraduate to graduate status.

**Eligibility**

Students majoring in BS Civil Engineering or BS Environmental Engineering may be eligible to pursue the blended program toward an MS in Civil and Environmental Engineering after completing all required support and CE/ENVE 300-level classes. Participation in the program is based on prior academic performance and other measures of professional promise, with a minimum GPA of 3.0. Please see page 96 for additional eligibility criteria.

**Program of Study**

Students originating in the BS Civil Engineering program are allowed to complete a capstone experience that integrates the senior project with the CE 599 graduate thesis. Students originating in the BS Environmental Engineering program are required to take both ENVE 466/7 Senior Project Design Laboratory I, II and complete the nine units of ENVE 599 thesis.

The blended program allows students to earn graduate credit for several of their senior electives, effectively decreasing the summed unit requirements for both degrees. A maximum of nine units can be shared between the B.S. and M.S. program requirements.

**BS CIVIL ENGINEERING**

For course prerequisites, please refer to the "Course Descriptions" section of this catalog. In scheduling your courses each quarter, consult with your academic advisor. * Satisfies GE requirement; see page 76.

**Freshman**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE 111</td>
<td>Introduction to Civil Engineering</td>
<td>1</td>
</tr>
<tr>
<td>CE 114</td>
<td>Intro CAD in Civil/Envirn Engr</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 124</td>
<td>Gen Chem for Engineering (B3/B4)*</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 125</td>
<td>Gen Chem for Engineering</td>
<td>4</td>
</tr>
<tr>
<td>ENGL 134</td>
<td>Writing: Exposition (A1)*</td>
<td>4</td>
</tr>
<tr>
<td>SCOM 101/102</td>
<td>Speech Communication (A2)*</td>
<td>4</td>
</tr>
<tr>
<td>ENGL 149</td>
<td>Technical Writing for Engineers (A3)*</td>
<td>4</td>
</tr>
</tbody>
</table>

2003-2005 Cal Poly Catalog
BS CIVIL ENGINEERING

☐ 60 units upper division
☐ 2.0 GPA
☐ USCP

* = Satisfies General Education requirement

MAJOR COURSES

CE 111 Introduction to Civil Engineering .................. 1
CE 114 Intro CAD in Civil & Environmental Engr .... 4
CE 201 Strength of Materials (5) or
    CE 204, CE 205 Strength of Materials I, II (3)(2) 5
CE 206 Strength of Materials Laboratory ............... 1
CE 221, 222 Fund Transportation Engr and Lab .... ... 3,2
CE 259 Civil Engineering Materials ...................... 2
BRAE 239 Engineering Surveying ....................... 4
GEOL 201 Physical Geology ................................ 3
MATE 210, 215 Materials Engineering and Lab ....... 3,1
MATH 241 Calculus IV ...................................... 4
MATH 244 Linear Analysis I ................................ 4
ME 211 Engineering Statics ................................ 3
ME 212 Engineering Dynamics ................................ 3
ME 302 Thermodynamics .................................... 3
ME 341 Fluid Mechanics ..................................... 3
PHYS 131 General Physics .................................. 4
PHYS 132 General Physics .................................. 4
PHYS 133 General Physics .................................. 4
PHYS 132 General Physics (Add'l Area B)* ............ 4
PHYS 131 General Physics (Add'l Area B)* ............ 4
CSC 231 Fortran or CSC 234 C/UNIX ....................... 2/3

1 Political economy elective (D2)* .......................... 4

Sophomore

CE 201 Strength of Materials (5) or CE 204, CE
    205 Strength of Materials I, II (3)(2) ................. 5
CE 206 Strength of Materials Laboratory ............... 1
CE 221, 222 Fund Transportation Engr and Lab ....... 3,2
CE 259 Civil Engineering Materials ...................... 2
BRAE 239 Engineering Surveying ....................... 4
GEOL 201 Physical Geology ................................ 3
MATE 210, 215 Materials Engineering and Lab ....... 3,1
MATH 241 Calculus IV ...................................... 4
MATH 244 Linear Analysis I ................................ 4
ME 211 Engineering Statics ................................ 3
ME 212 Engineering Dynamics ................................ 3
ME 302 Thermodynamics .................................... 3
ME 341 Fluid Mechanics ..................................... 3
PHYS 133 General Physics .................................. 4
Self development elective (CSU Area E) (D4)* ......... 4

Support Courses

BIO 213 and ENGR/BRAE 213 (B2)* ....................... 2,2
BRAE 239 Engineering Surveying ....................... 4
CHEM 124 Gen Chem for Engineering (B3/B4)* ........ 4
CHEM 125 Gen Chem for Engineering ..................... 4
CSC 231 Fortran for Engineering Students or
    CSC 234 C and UNIX ..................................... 2/3

Junior

CE 336 Water Resources Engineering .................... 4
CE 337 Hydraulics Laboratory ............................. 1
CE 351 Structural Analysis ................................ 5
CE 355 Reinforced Concrete Design ...................... 3
CE 381, 382 Geotechnical Engineering and Lab ....... 4,1
CE 407 Structural Dynamics ................................ 4
CE 453 Structural Steel Design ............................ 3
ENVE 331 Intro to Environmental Engineering ......... 4
CSC 341 Numerical Analysis or IME 314 Engr Econ ..... 4/3
EE 201 Electric Circuits Theory ........................... 3
STAT 312 Statistical Methods for Engineers (B6)* .... 4
American experience elective (D1)* ...................... 4
Philosophy elective (C2)* .................................. 4
BIO 213 and ENGR/BRAE 213 (B2)* ....................... 2,2

Senior

CE 461, 462 Senior Project or
    CE 466, 467 Senior Project Design Lab ............... 2,2
Fine and performing arts elective (C3)* .................. 4
Literature, philosophy, arts (300-400 level) (C4)* .... 4
Comparative social institutions elective (D3)* ......... 4
Self development elective (CSU Area E) (D4)* ......... 4

Support Courses

BIO 213 and ENGR/BRAE 213 (B2)* ....................... 2,2
BRAE 239 Engineering Surveying ....................... 4
CHEM 124 Gen Chem for Engineering (B3/B4)* ........ 4
CHEM 125 Gen Chem for Engineering ..................... 4
CSC 231 Fortran for Engineering Students or
    CSC 234 C and UNIX ..................................... 2/3

1 ECON 201 or equivalent if planning to take IME 314.
2 To be selected in accordance with the A.B.E.T. 24-unit and Culminating
    Engineering Design requirement, after consultation with your
    academic advisor.
3 More than 4 units of advisor-approved coursework outside CE/ENVE is
    only permitted in special/ unusual cases, requires written justification
    by the student, and approval by the Department Chair.
4 No more than 4 total units of advisor-approved technical elective credit
    from CE 400, 500 and ENVE 400, 500 combined.
<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 212 Engineering Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>ME 302 Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>ME 341 Fluid Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 131, 133 General Physics (Add’l Area B)*</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 132, 133 General Physics</td>
<td>4,4</td>
</tr>
<tr>
<td>STAT 312 Statistical Methods for Engr (B6)*</td>
<td>4</td>
</tr>
<tr>
<td><strong>GENERAL EDUCATION (GE)</strong></td>
<td><strong>87</strong></td>
</tr>
</tbody>
</table>

**Area A Communication (8 units)**
- A1 Expository Writing * 4 units in Support .......................... 4
- A2 Oral Communication .................................................. 4
- A3 Reasoning, Argumentation, and Writing * 4 units in Support ...... 0

**Area B Science and Mathematics (no addl units req’d)**
- B1 Mathematics/Statistics * 8 units in Support................. 0
- B2 Life Science * 4 units in Support............................. 4
- B3 Physical Science * 4 units in Support....................... 0
- B4 One lab taken with either a B2 or B3 course................. 4
- B5 (requirement for Liberal Arts students only)................ 4
- B6 Upper-division Area B * 4 units in Support .............. 0
- Additional Area B units * 8 units in Support ......... 0

**Area C Arts and Humanities (16 units)**
- C1 Literature ......................................................... 4
- C2 Philosophy ....................................................... 4
- C3 Fine/Performing Arts ........................................... 4
- C4 Upper-division elective ....................................... 4

**Area D/E Society and the Individual (16 units)**
- D1 The American Experience (40404) ................................ 4
- D2 Political Economy ................................................ 4
- D3 Comparative Social Institutions ................................ 4
- D4 Self Development (CSU Area E) ................................ 4

**ELECTIVES**

---

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 201 Strength of Materials (5) or</td>
<td></td>
</tr>
<tr>
<td>CE 204, 205 Strength of Materials I, II (3)(2)........................</td>
<td></td>
</tr>
<tr>
<td>ENVE 309 Noise and Vibration Control...................................</td>
<td>3</td>
</tr>
<tr>
<td>ENVE 325 Environmental Air Quality ......................................</td>
<td>3</td>
</tr>
<tr>
<td>ENVE 331 Intro Environmental Engineering ..................................</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 312 Survey of Organic Chemistry <em>(transfer equivalent CHEM 212)</em></td>
<td>5</td>
</tr>
<tr>
<td>EE 201 Electric Circuit Theory ...........................................</td>
<td>3</td>
</tr>
<tr>
<td>MATH 241 Calculus IV ....................................................</td>
<td>4</td>
</tr>
<tr>
<td>MATH 244 Linear Analysis I ...............................................</td>
<td>4</td>
</tr>
<tr>
<td>ME 211 Engineering Statics ................................................</td>
<td>3</td>
</tr>
<tr>
<td>ME 212 Engineering Dynamics .............................................</td>
<td>3</td>
</tr>
<tr>
<td>ME 302 Thermodynamics ...................................................</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 133 General Physics ................................................</td>
<td>4</td>
</tr>
<tr>
<td>STAT 312 Statistical Methods for Engineers (B6)*</td>
<td>4</td>
</tr>
<tr>
<td><strong>Sophomore</strong></td>
<td><strong>51</strong></td>
</tr>
</tbody>
</table>

**Junior**
- CE 336 Water Resources Engineering ....................................| 4     |
- CE 337 Hydraulics Laboratory ...........................................| 1     |
- ENVE 304 Thermodynamics of Processes ..................................| 3     |
- ENVE 421 Mass Transfer Operations ......................................| 3     |
- ENVE 436 Intro Hazardous Waste Management ................................| 3     |
- ENVE 438 Water & Wastewater Treatment Design ........................| 3     |
- ENVE 439 Solid Waste Management ........................................| 3     |
- ENVE 455 Environmental Health and Safety ................................| 4     |
- ENGL 149 Technical Writing for Engineers (A3)* ........................| 4     |
- MCRO 221 Microbiology (B2)* ............................................| 4     |
- ME 341 Fluid Mechanics ..................................................| 3     |
- Literature elective (C1)* ..............................................| 4     |
- Philosophy elective (C2)* .............................................| 4     |

**Senior**
- CE 381 Geotechnical Engineering ..........................................| 4     |
- CE 434 Groundwater Hydraulics and Hydrology ...........................| 3     |
- ENVE 411 Air Pollution Control ...........................................| 3     |
- ENVE 416 Environmental Process Modeling ................................| 4     |
- ENVE 426 Air Quality Measurements ......................................| 3     |
- ENVE 434 Water Quality Measurements ...................................| 2     |
- ENVE 450 Industrial Pollution Prevention ................................| 4     |
- ENVE 466, 467 Senior Project Design Laboratory .......................| 2,2   |
- Fine and performing arts elective (C3)* ................................| 4     |
- Literature, philosophy, arts (300-400 level) (C4)* (PHIL 340 or FNR 360 recommended) | 4     |
- Comparative social institutions elective (D3) .......................| 4     |

---

**BS ENVIRONMENTAL ENGINEERING**

For course prerequisites, please refer to the "Course Descriptions" section of this catalog. In scheduling your courses each quarter, consult with your academic advisor. * Satisfies GE requirement; see page 76.

**Freshman**
- ENVE 111 Intro to Env. Engineering Profession .....................| 1     |
- CHEM 124 Gen Chem for Engineering (B3)/B4)* .......................| 4     |
- CHEM 125 Gen Chem for Engineering ..................................| 4     |
- CHEM 129 General Chemistry ...........................................| 4     |
- CSC 231 Fortran or CSC 234 C/UNIX ................................| 2/3   |
- MATH 141, 142 Calculus I, II (B1)* ..................................| 4,4   |
- MATH 143 Calculus III (Add’l Area B)* ................................| 4     |
- PHYS 131 General Physics (Add’l Area B)* ..........................| 4     |
- PHYS 132 General Physics .............................................| 4     |
- ENGL 134 Writing: Exposition (A1)* ..................................| 4     |
- SCOM 101/102 Speech Communication (A2)* ..........................| 4     |
- American experience elective (D1)* ..................................| 4     |
- Political economy elective (D2)* ...................................| 4     |

**2003-2005 Cal Poly Catalog**
### BS ENVIRONMENTAL ENGINEERING

- **60 units upper division**
- **GWR**
- **2.0 GPA**
- **USCP**

* = Satisfies General Education requirement

#### MAJOR COURSES

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE 201 or CE 204, 205</td>
<td>Strength of Materials</td>
<td>5</td>
</tr>
<tr>
<td>CE 336</td>
<td>Water Resources Engineering</td>
<td>4</td>
</tr>
<tr>
<td>CE 337</td>
<td>Hydraulics Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>CE 381</td>
<td>Geotechnical Engineering</td>
<td>4</td>
</tr>
<tr>
<td>CE 434</td>
<td>Groundwater Hydraulics and Hydrology</td>
<td>3</td>
</tr>
<tr>
<td>ENVE 111</td>
<td>Intro to Env. Engineering Profession</td>
<td>1</td>
</tr>
<tr>
<td>ENVE 304</td>
<td>Thermodynamics of Processes</td>
<td>3</td>
</tr>
<tr>
<td>ENVE 309</td>
<td>Noise and Vibration Control</td>
<td>3</td>
</tr>
<tr>
<td>ENVE 325</td>
<td>Environmental Air Quality</td>
<td>3</td>
</tr>
<tr>
<td>ENVE 331</td>
<td>Intro to Environmental Engineering</td>
<td>4</td>
</tr>
<tr>
<td>ENVE 411</td>
<td>Air Pollution Control</td>
<td>3</td>
</tr>
<tr>
<td>ENVE 416</td>
<td>Environmental Process Modeling</td>
<td>4</td>
</tr>
<tr>
<td>ENVE 421</td>
<td>Mass Transfer Operations</td>
<td>3</td>
</tr>
<tr>
<td>ENVE 426</td>
<td>Air Quality Measurements</td>
<td>3</td>
</tr>
<tr>
<td>ENVE 434</td>
<td>Water Quality Measurements</td>
<td>2</td>
</tr>
<tr>
<td>ENVE 436</td>
<td>Intro Hazardous Waste Management</td>
<td>3</td>
</tr>
<tr>
<td>ENVE 438</td>
<td>Water &amp; Wastewater Treatment Design</td>
<td>3</td>
</tr>
<tr>
<td>ENVE 439</td>
<td>Solid Waste Management</td>
<td>3</td>
</tr>
<tr>
<td>ENVE 450</td>
<td>Industrial Pollution Prevention</td>
<td>4</td>
</tr>
<tr>
<td>ENVE 455</td>
<td>Environmental Health and Safety</td>
<td>4</td>
</tr>
<tr>
<td>ENVE 466, 467</td>
<td>Senior Project Design Laboratory</td>
<td>2,2</td>
</tr>
</tbody>
</table>

1, 2 Advisor approved technical electives...

#### SUPPORT COURSES

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 124</td>
<td>Gen Chem for Engineering (B3/B4)*</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 125</td>
<td>Gen Chem for Engineering</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 129</td>
<td>General Chemistry</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 312</td>
<td>Survey of Organic Chemistry <em>(transfer equivalent CHEM 212)</em></td>
<td>5</td>
</tr>
<tr>
<td>CSC 231</td>
<td>Fortran or CSC 234 C/UNIX</td>
<td>2</td>
</tr>
<tr>
<td>EE 201</td>
<td>Electric Circuit Theory</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 149</td>
<td>Technical Writing for Engineers (A3)*</td>
<td>4</td>
</tr>
<tr>
<td>MATH 141, 142</td>
<td>Calculus I, II (B1)*</td>
<td>4,4</td>
</tr>
<tr>
<td>MATH 143</td>
<td>Calculus III <em>(Add’l Area B)</em></td>
<td>4</td>
</tr>
<tr>
<td>MATH 241</td>
<td>Calculus IV</td>
<td>4</td>
</tr>
<tr>
<td>MATH 244</td>
<td>Linear Analysis I</td>
<td>4</td>
</tr>
<tr>
<td>MCRO 221</td>
<td>Microbiology (B2)*</td>
<td>4</td>
</tr>
<tr>
<td>ME 211, 212</td>
<td>Engr Statics, Engr Dynamics</td>
<td>3,3</td>
</tr>
<tr>
<td>ME 302</td>
<td>Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>ME 341</td>
<td>Fluid Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 131</td>
<td>General Physics <em>(Add’l Area B)</em></td>
<td>4</td>
</tr>
<tr>
<td>PHYS 132, 133</td>
<td>General Physics</td>
<td>4,4</td>
</tr>
<tr>
<td>STAT 312</td>
<td>Statistical Methods/Engrs (B6)*</td>
<td>4</td>
</tr>
</tbody>
</table>

#### ELECTIVES

54

1, 2 Advisor approved technical electives...

#### GENERAL EDUCATION (GE)

72 units required; 32 units are in Support.

→ See page 76 for complete GE course listing.

→ Minimum of 8 units required at the 300-400 level.

#### Area A Communication (8 units)

<table>
<thead>
<tr>
<th>Area A Communication</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 Expository Writing</td>
<td>4</td>
</tr>
<tr>
<td>A2 Oral Communication</td>
<td>4</td>
</tr>
<tr>
<td>A3 Reasoning, Argumentation, and Writing *</td>
<td>4</td>
</tr>
</tbody>
</table>

#### Area B Science and Mathematics (no additional units required)

<table>
<thead>
<tr>
<th>Area B Science and Mathematics</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1 Mathematics/Statistics * 8 in Support</td>
<td>0</td>
</tr>
<tr>
<td>B2 Life Science * 4 units in Support</td>
<td>0</td>
</tr>
<tr>
<td>B3 Physical Science * 4 in Support</td>
<td>0</td>
</tr>
<tr>
<td>B4 One lab taken with either a B2 or B3 course</td>
<td>0</td>
</tr>
<tr>
<td>B5 (requirement for Liberal Arts students only)</td>
<td>0</td>
</tr>
<tr>
<td>B6 Upper-division Area B * 4 in Support</td>
<td>0</td>
</tr>
<tr>
<td>Additional Area B units* 8 in Support</td>
<td>0</td>
</tr>
</tbody>
</table>

#### Area C Arts and Humanities (16 units)

<table>
<thead>
<tr>
<th>Area C Arts and Humanities</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1 Literature</td>
<td>4</td>
</tr>
<tr>
<td>C2 Philosophy</td>
<td>4</td>
</tr>
<tr>
<td>C3 Fine/Performing Arts</td>
<td>4</td>
</tr>
<tr>
<td>C4 Upper-division elective (PHIL 340 or FNR 360 recommended)</td>
<td>4</td>
</tr>
</tbody>
</table>

#### Area D/E Society and the Individual (16 units)

<table>
<thead>
<tr>
<th>Area D/E Society and the Individual</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1 The American Experience (40404)</td>
<td>4</td>
</tr>
<tr>
<td>D2 Political Economy</td>
<td>4</td>
</tr>
<tr>
<td>D3 Comparative Social Institutions</td>
<td>4</td>
</tr>
<tr>
<td>D4 Self Development (CSU Area E)</td>
<td>4</td>
</tr>
</tbody>
</table>

#### Electives

0

---

1. To be selected in accordance with the A.B.E.T. 24-unit and Culminating Engineering Design requirement, in consultation with your academic advisor.

2. No more than 4 units of ENVE 400 or CE 400 can be counted towards technical electives.
# MS Civil and Environmental Engineering

## General Characteristics
The Master of Science program in Civil and Environmental Engineering has the following objectives:

- Job-entry education for the more complex areas of engineering, such as research and development, innovative design, systems analysis and design, and managerial engineering;
- Updating opportunities for practicing engineers;
- Graduate preparation for further study in engineering, leading to the Doctor of Engineering or Ph.D. degree;
- Graduates who are able to maintain currency in their fields.

## Prerequisites
For admission as a classified graduate student, an applicant must hold a bachelor's degree in engineering or a closely related physical science with a minimum GPA of 3.0 in the last 90 quarter units (60 semester) attempted. Applicants are required to submit satisfactory scores for the General (Aptitude) Test of the Graduate Record Examination. An applicant who meets these standards but lacks prerequisite coursework may be admitted as a conditionally classified student and must make-up any deficiencies before advancement to classified graduate standing.

Information pertaining to specific requirements for admission to graduate standing (classified or conditionally classified) may be obtained from the Graduate Coordinator, Civil and Environmental Engineering Department.

## Program of Study
Graduate students must file a formal study plan with their advisor, department, college and university graduate studies office by no later than the end of the quarter in which the 12th unit of approved courses is completed. The formal program of study must include a minimum of 45 units (at least 24 of which must be at the 500 level). With the graduate advisor's approval, students select their elective units in one of the following areas of study: geotechnical engineering, transportation and planning, or water resources and environmental engineering.

The broad curriculum requirements for the MS in Civil and Environmental Engineering are:

- a core of 10 units as required;
- a minimum of 26 units of advisor approved electives within the major;
- a minimum of 9 units of advisor-approved electives outside the department;
- at least 24 units of the 45 unit program at the 500 level;
- a comprehensive written examination (non-thesis option) or an oral defense examination (thesis option).

Two program options are available:

### Non-thesis option
45 units of advisor-approved coursework and a written comprehensive examination administered by a panel of three faculty (maximum of three opportunities to pass this examination).

### Required Courses

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE 591 Graduate Seminar (1)</td>
<td>10</td>
</tr>
<tr>
<td>CE 599/ENVE 599 Design Project (Thesis) (9) or</td>
<td></td>
</tr>
<tr>
<td>additional 9 units of advisor approved analysis</td>
<td></td>
</tr>
<tr>
<td>and design electives within the major (non-thesis</td>
<td></td>
</tr>
<tr>
<td>option) and Comprehensive Examination.</td>
<td></td>
</tr>
</tbody>
</table>

### Advisor approved analysis and design electives
(normal to be selected from the following list after consultation with your academic advisor and the CE/ENVE graduate coordinator):  
- CE 400 1, CE 401, CE 402, CE 407, CE 421, CE 422, CE 424, CE 431, CE 432, CE 434, CE 440, CE 453, CE 454, CE 457, CE 458, CE 459, CE 466, CE 467, CE 481, CE 482, CE 483, CE 500 1, CE 501, CE 504, CE 505, CE 521, CE 522, CE 523, CE 525, CE 528, CE 529, CE 533, CE 535, CE 537, CE 554, CE 555, CE 558, CE 559, CE 571, CE 573, CE 574, CE 581, CE 582, CE 583, CE 584, CE 585, CE 586, CE 599
- ENVE 400 1, ENVE 411, ENVE 416, ENVE 421, ENVE 434, ENVE 436, ENVE 437, ENVE 438, ENVE 439, ENVE 443, ENVE 450, ENVE 455, ENVE 465, ENVE 466, ENVE 467, ENVE 500 1, ENVE 534, ENVE 535, ENVE 536, ENVE 541, ENVE 551

1 No more than 4 total units of advisor-approved technical elective credit from CE 400, 500 and ENVE 400, 500 combined.
Computer Engineering

Program Office
Engineering East Building (20), Room 215
(805) 756-1229
www.cpe.calpoly.edu

College of Engineering Advising Center
Engineering South (40), Room 115
(805) 756-1461

Director, C. Arthur MacCarley
James L. Beug Diana M. Keen
David B. Braun Albert A. Liddicoat
Fred W. DePiero Leonard D. Myers
Joseph E. Grimes Phillip L. Nico
James G. Harris John A. Saghri
Lewis D. Hitchner Richard S. Sandige
John Y. Hsu Hugh M. Smith
Martin E. Kaliski Daniel J. Stearns

ACADEMIC PROGRAM

BS Computer Engineering

The Bachelor of Science in Computer Engineering prepares students interested in the design and application of computers and computer-based systems. The program incorporates a firm foundation in both electrical engineering and computer science, with a focus on the integration of hardware and software systems.

The mission of the Computer Engineering Program (CPE) is to provide students with a well-rounded education encompassing the theory and practice of selected, balanced topics in electrical engineering and computer science, to enable students to contribute and continue their education in a wide range of computer-related engineering careers. The program seeks to emphasize “hands-on” experience, problem solving skills, the creative process and responsible action. Through professional development activities, faculty contribute to the advancement of the state-of-the-art, and strive to directly incorporate this experience in the classroom.

The primary educational objectives of the Computer Engineering Program are to:

1. provide theoretical background in fundamentals underlying computer engineering.
2. provide technical knowledge and experience required for the practice of computer engineering.
3. provide hands-on experience to develop proficiency in experimental, testing, and research skills.
4. develop communications skills, establish ethical standards of practice, and foster life-long learning skills.
5. provide a well-rounded understanding of social, interpersonal, artistic, and world issues, and the relationship between these and the practice of computer engineering.

In addition to the general abilities expected of College of Engineering graduates, computer engineering students are expected to graduate with:

- a knowledge of probability and statistics appropriate to computer engineering applications;
- a knowledge of mathematics through differential and integral calculus, basic sciences, and engineering sciences to analyze and design complex devices and systems containing hardware and software components; and
- a knowledge of discrete mathematics.

The program prepares graduates for professional practice in industry, as well as continued study in graduate school. Cal Poly's “learn by doing” philosophy is emphasized by integrating design throughout the curriculum, especially in the numerous design-centered laboratories. In the required senior design project, which is completed in a two-quarter set of capstone courses, students demonstrate their understanding of engineering knowledge and their ability to apply that knowledge creatively to practical problems.

This integrated approach will allow students to work effectively in such diverse areas as digital systems simulation and digital control systems. Knowledge and laboratory experience in computer architecture and structures will provide the understanding necessary to design and build computer systems, computer networks and digital communications systems. A thorough knowledge of modern microprocessors enables the graduate to apply these machines in applications such as robotics and data acquisition. Twelve units of technical electives allow students the option to specialize in an area of special interest. Current technical elective tracks are:

- computer architecture and system integration
- computer networks
- computer based controls and robotics
- software systems
- graphics and multimedia
- electronics implementation and VLSI

In addition to a sound theoretical background in computer engineering concepts, students experience practical design courses intended to build problem solving skills. Laboratory courses supplement the program to develop...
“hands on” skills in all areas of study. Students are exposed to a wide variety of computing equipment: microprocessor development systems, workstations and personal computers, and advanced network hardware and software. Active student groups of interest to computer engineering majors include the IEEE Computer Society, the IEEE Student Branch, the Association for Computing Machinery, and many other project-oriented student clubs and activities.

Graduates of the Computer Engineering Program are qualified for admission to Cal Poly master’s degree programs in electrical engineering, computer science, and general engineering (including biomedical engineering). The opportunity also exists for advanced students to begin graduate study in these areas prior to completion of the BS degree, via a “blended 4+1” program. This opportunity provides a number of advantages to qualified students, and makes it possible for completion of both the BS and MS degrees in as little as 5 years. Computer engineering students participating in a blended 4+1 program are permitted to fulfill the computer engineering senior project requirement with the master’s degree thesis. Students must be prepared for engineering practice via the curriculum which culminates in a major design experience based on the knowledge and skills acquired in earlier coursework and incorporating engineering standards and realistic constraints, as listed in the ABET Engineering Criteria. Therefore, all "Blended BS + MS Program" students, even those students completing the Master of Science in Engineering, must have a master's thesis with this major design experience requirement included in to complete the undergraduate degree. The thesis supervisor will assist the student in ensuring that this requirement is met. Further details are provided in the graduate study sections for each of these programs.

BS COMPUTER ENGINEERING

For course prerequisites, please refer to the "Course Descriptions" section of this catalog. In scheduling your courses each quarter, consult with your academic advisor. * Satisfies GE requirement; see page 76.

Freshman

CPE 100 Computer Engineering Orientation ........ 1
CPE 101 Fund Computer Science I .......................... 4
CPE 102, 103 Fund Computer Science II, III .......... 4,4
CSC 141 Discrete Structures I ................................ 4
ENGL 134 Writing: Exposition (A1)* .................. 4
IME 156 Basic Electronics Manufacturing or
  IME 157 Electronics Manufacturing .................. 2
SCOM 101/102 Speech Communication (A2)* .... 4
MATH 141, 142 Calculus I, II (B1)* ................. 4,4
MATH 143 Calculus III (Add’l Area B)* ........... 4
PHYS 131 General Physics (Add’l Area B) .......... 4
Fine and performing arts elective (C3)* .......... 4

Sophomore

CPE 129, 169 Digital Design & Lab ................... 3,1
CPE 229, 269 Computer Design and Assembly
  Language Programming and Lab .................... 3,1
CHEM 124 Gen Chem for Engineering (B3/B4)* .. 4
EE 213, 253 Basic Circuit Analysis and Lab ....... 4,1
EE 214, 254 Steady-State Circuit Analysis and Lab 4,1
MATH 241 Calculus IV .................................. 4
MATH 244 Linear Analysis I ............................ 4
PHYS 132, 133 General Physics ....................... 4,4
PHYS 211 Modern Physics .............................. 4
Philosophy elective (C2)* ............................. 4
American experience elective (D1)* ............... 4

Junior

CPE 250 Systems Programming ......................... 4
CPE 315 Computer Architecture ....................... 4
CPE 316 Micro Controllers and Embedded
  Applications ............................................ 4
CPE 329 Programmable Logic and
  Microprocessor-Based Systems Design ........... 4
CPE 350 CPE Capstone Preparation .................. 1
CPE 453 Operating Systems I .......................... 4
EE 228 Continuous-Time Signals and Systems .... 4
EE 306, 346 Semiconductor Device Electronics
  and Lab ............................................... 3,1
EE 307, 347 Digital Electronics and Integrated
  Circuits and Lab ..................................... 3,1
ENGL 149 Technical Writing for Engineers (A3)* 4
Literature elective (C1)* ............................. 4
Literature, philosophy, arts (300-400 level) (C4)* 4
Comparative social institutions elective (D3)* .... 4

Senior

CPE 450 CPE Capstone Project .......................... 4
CPE 464 Introduction to Computer Networks .. 4
CPE 461, 462 Senior Project ......................... 3,2
BIO 213 and ENGR/BRAE 213 (B2)* ............... 2,2
ME 211 Engr Statics or MATE 210, 215 (4) . 3
STAT 350 Probability and Random Processes for
  Engineers (B6)* .................................... 4
Political economy elective (D2)* ...................... 4
Self development elective (CSU Area E) (D4)* .. 4
Advisor approved technical electives ............. 12

44

190
BS COMPUTER ENGINEERING

☐ 60 units upper division  ☐ GWR
☐ 2.0 GPA  ☐ USCP

* = Satisfies General Education requirement

MAJOR COURSES
CPE 100 Computer Engineering Orientation ............... 1
CPE 101 Fundamentals Computer Science I ............... 4
CPE 102, 103 Fund Computer Science II, III .............. 4,4
CPE 129, 169 Digital Design and Lab ..................... 3,1
CPE 229, 269 Computer Design and Assembly
   Language Programming and Lab ......................... 3,1
CPE 250 Systems Programming ................................ 4
CPE 315 Computer Architecture ............................. 4
CPE 316 Micro Controllers and Embedded Apps .......... 4
CPE 329 Programmable Logic and
   Microprocessor-Based Systems Design ................. 4
CPE 350 CPE Capstone Preparation ......................... 1
CPE 450 CPE Capstone Project ............................. 4
CPE 453 Operating Systems I ................................ 4
CPE 461, 462 Senior Project ................................. 3,2
CPE 464 Introduction to Computer Networks .............. 4
CSC 141 Discrete Structures I ............................... 4
EE 213, 253 Basic Circuit Analysis and Lab .............. 4,1
EE 214, 254 Steady-State Circuit Analysis and Lab ....... 4,1
EE 228 Continuous-Time Signals and Systems ............ 4
EE 306, 346 Semiconductor Device Electronics
   and Lab.......................................................... 3,1
EE 307, 347 Digital Integrated Electronics and Lab ....... 3,1
Advisor approved technical electives ..................... 12

93

SUPPORT COURSES
BIO 213 and ENGR/BRAE 213 (B2)* ....................... 2,2
CHEM 124 Gen Chem for Engineering (B3/B4)* .......... 4
ENGL 149 Technical Writing for Engineers (A3)* ....... 4
IME 156 Basic Electronics Manufacturing
   or IME 157 Electronics Manufacturing .................. 2
MATH 141, 142 Calculus I, II (B1)* ....................... 4,4
MATH 143 Calculus III (Add’l Area B)* ................... 4
MATH 241 Calculus IV ........................................ 4
MATH 244 Linear Analysis I .................................. 4
ME 211 Engr Statics or MATE 210, 215 (4) ............... 3
PHYS 131 General Physics (Add’l Area B)* ............... 4
PHYS 132, 133 General Physics ............................. 4,4
PHYS 211 Modern Physics .................................... 4
STAT 350 Probability and Random Processes for
   Engineers (B6)* ............................................... 4

57

GENERAL EDUCATION (GE)

72 units required; 32 units are in Major/Support.
See page 76 for complete GE course listing.
Minimum of 8 units required at the 300-400 level.

Area A Communication (8 units)
A1 Expository Writing ........................................ 4
A2 Oral Communication ....................................... 4
A3 Reasoning, Argumentation, and Writing * 4 units in Support ........................................ 0

Area B Science and Mathematics (no additional units required)
B1 Mathematics/Statistics * 8 units in Support ........ 0
B2 Life Science * 4 units in Support ...................... 0
B3 Physical Science * 4 units in Support ............... 0
B4 One lab taken with either a B2 or B3 course
B5 (requirement for Liberal Arts students only)
B6 Upper-division Area B * 4 units in Support ........ 0
Additional Area B units * 8 units in Support .......... 0

Area C Arts and Humanities (16 units)
C1 Literature ..................................................... 4
C2 Philosophy .................................................... 4
C3 Fine/Performing Arts ...................................... 4
C4 Upper-division elective ................................. 4

Area D/E Society and the Individual (16 units)
D1 The American Experience (40404) ...................... 4
D2 Political Economy ......................................... 4
D3 Comparative Social Institutions ...................... 4
D4 Self Development (CSU Area E) ....................... 4

40

190

ELECTIVES ......................................................... 0

2003-2005 Cal Poly Catalog
Computer Science

Department Office
Computer Science Bldg. (14), Room 254
(805) 756-2824
www.csc.calpoly.edu

College of Engineering Advising Center
Engineering South (40), Room 115
(805) 756-1461

Department Chair, Timothy J. Kearns
James L. Beug
Raymond E. Boche
Lois H. Brady
W. Chris Buckalew
Laurian M. Chirica
John B. Connely
Gene Fisher
Joseph E. Grimes
Lewis E. Hitchner
John Y. Hsu
Aaron W. Keen
Diana M. Keen
Elmo A. Keller

Franz J. Kurfess
Mei-Ling Liu
Sigurd Meldal
Leonard D. Myers
Phillip L. Nicos
Hasmil Gharibyan Paulson
Cornel K. Pokorny
Erika Rogers
Hugh Smith
Clinton A. Staley
Daniel J. Stearns
Clark S. Turner

ACADEMIC PROGRAMS
BS, MS Computer Science
BS Computer Engineering
BS Software Engineering
Computer Science Minor

The Computer Science Department educates students in the discipline of computer science and teaches them to apply their education to solve practical problems in a socially responsible way. To support the department’s educational mission, faculty engage in research and professional development.

In all of the department’s programs, laboratory experiences ensure that students have both a theoretical and practical understanding of computer science. Individual and team projects, culminating in the capstone experience of a senior project, reinforce concepts and provide students the opportunity to apply and communicate their knowledge.

The department has active student chapters of the Association for Computing Machinery, IEEE Computer Society and Upsilon Pi Epsilon (the national computer honor society). Student teams compete in national competitions and student organizations sponsor industry/student events.

The department, with industry support, provides a modern computing environment that includes the most current software tools running on a variety of workstations and servers. Projects in advanced courses are supported by specialized laboratories for databases, computer architecture, operating systems, software engineering, computer networks, computer graphics, and human/computer interaction.

BS Computer Science

The BS Computer Science program provides in-depth study of computer science fundamentals and practice, including programming concepts and languages, software engineering, operating systems and computer architecture.

In addition, the major offers a wide choice of technical electives in a structure that allows students to focus on particular areas and their application. Typical areas of emphasis include databases, distributed computing, software engineering, programming languages, graphical user interfaces, operating systems, computer networks, computer graphics, and artificial intelligence.

The curriculum is project-oriented and develops students’ ability to solve problems using modern computing concepts. Students can expect to complete many projects in a variety of languages and on a variety of computer systems. During their last year of study, students complete a senior project spanning two academic quarters. The senior project is done either as an individual or as a member of a team.

Graduates of the computer science program are well prepared to become successful professionals and to pursue graduate study. They are sought by the computer industry for positions as software developers, quality assurance and test engineers, and other technical positions in computer-related industries.

Graduates in computer science:
- Have a broad knowledge of computer science and substantial knowledge of at least one key area of computer science;
- Are prepared to be successful professionals, and, if they desire, are prepared to pursue graduate study;
- Think independently, acquire knowledge, and continue their development as professionals;
- Apply scientific and engineering methodology to the design, implementation, analysis, and evaluation of computer-based systems;
- Communicate effectively, both orally and in writing, and collaborate effectively in teams; and
- Are prepared for the ethical, societal, and global issues associated with the computing field.
The BS Computer Science program is accredited by the Computing Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012, telephone: (410) 347-7700.

**BS Software Engineering**
The BS in Software Engineering prepares students to become software engineers: professionals who develop software products on time, within budget, and that meet customer requirements. Building on the fundamentals of computer science, the program focuses on practical aspects of building and deploying real software systems in a socially responsible way. The program’s educational mission supports the faculty in research and professional development that keeps them current in their field and in touch with current industry practices and trends.

The hallmark of the program is “hands on” experience where students follow a curriculum that builds on traditional computer science but differs from the BS in Computer Science in the following ways:

1. Classes emphasize the team approach to building software and provide leadership opportunities for every student.
2. Classes place an emphasis on software processes and lifecycles.
3. Classes include significant learning in engineering and management areas such as quality assurance, testing, metrics, maintenance, configuration management and personnel management.
4. The curriculum has a stronger emphasis on mathematics and the use of engineering methods in software design.

The software engineering curriculum culminates in a year-long capstone sequence where the students work in teams to build a large software system. Students are expected to complete a co-operative education experience prior to enrollment in these courses.

Freshmen must choose their major when they apply for admission. The software engineering program is designed to be flexible for those students who might want to refocus their efforts after beginning in another program. To that end, the Software Engineering lower division curriculum is quite similar to the Computer Science and Computer Engineering programs.

The software industry increasingly requires those with a suitable engineering background for their cutting edge projects. Graduates with a BS in Software Engineering can expect to find significant opportunities in software development and management, software engineering and marketing.

**BS Computer Engineering**
For information regarding this program, please refer to Computer Engineering. This program is jointly administered by the Computer Science Department and the Electrical Engineering Department.

**Blended BS + MS Computer Science**
The department offers an accelerated program for motivated, well-qualified students. The blended program allows BS Computer Science, BS Computer Engineering, and BS Software Engineering students to progress toward the Master’s degree while still undergraduates. The scheduling flexibility provided by the program enables students to complete the BS and MS degrees efficiently.

**Eligibility**
Students majoring in BS Computer Science, BS Software Engineering, and BS Computer Engineering are eligible to apply to the blended program if they meet the following minimum eligibility requirements:

- Junior status and completion of 20 units of CSC/CPE 103;
- Meet the minimum GPA requirement of 3.3; and
- Have not enrolled in senior project.

Participation in the program is based on prior academic performance and other measures of professional promise. Students are selected by a faculty committee.

**Program of Study**
Students in the blended program complete all courses required for the MS degree and all courses required for the BS except the senior project. Completion of the MS thesis satisfies the senior project requirement. Please refer to your undergraduate degree program for a restriction on the master’s thesis where a major design experience requirement is included in order to complete the undergraduate degree.

Upon completion of the program, students are awarded the BS and the MS degrees at the same graduation ceremony and at the same time. Degrees are earned concurrently, not serially.

**Computer Science Minor**
Nearly all disciplines need to integrate and utilize the capabilities of computers. The Computer Science minor consists of a core of 16 units and the choice of a track for specialized study. The core provides the common knowledge and skills needed by anyone who wishes to advance further in computer science. The track consists of one or more required courses and several restricted elective courses.

Admission to the minor is limited and selection will be made based upon the applicant’s performance in the core courses. Please see the College of Engineering Advising Center for further information before planning to enter the minor.

The courses taken in the minor can be counted toward the student’s major, support and general education & breadth requirements. Once students have completed CSC/CPE 101, 102, 103, and 141 with a 3.0 GPA (B grade) in each course based on the first time the course is taken, and if they have a
Cal Poly cumulative GPA of a 3.0 or higher, they should make an appointment to see the director of the College of Engineering Advising Center to request acceptance to the minor. The Computer Science minor is not open to CSC, CPE or Software Engineering (SE) major students. Questions concerning the minor should be directed to the College of Engineering Advising Center.

**Curriculum for Computer Science Minor**

CSC 101,102,103 Fund Computer Science I,II,III 4,4,4
CSC 141 Discrete Structures I 4

Tracks (Select one) 8

**Database and Application Development**

- CSC 366 Database, Modeling, Design, & Implement
- CSC 367 Introduction to Database Systems

**Computer Architecture**

- CSC 315 Computer Architecture
- CSC 316 Micro Controllers and Embedded Apps.

**Artificial Intelligence**

- CSC 480 Artificial Intelligence
- CSC 481 Knowledge Based Systems

**Graphics**

- CSC 471 Introduction to Computer Graphics
- CSC 473 Advanced Rendering Techniques or CSC 474 Computer Animation or CSC 476 Real-Time 3D Computer Graphics Software

**Human-Computer Interaction**

- CSC 482 User-centered Interface Design & Dev.
- CSC 486 Human-Computer Interaction

**Professional Software Development**

- CSC 305 Individual Software Design & Developmt
- CSC 435 Intro to Object-Oriented Design Using GUIs

**Upper-division restricted electives** 8

### BS COMPUTER SCIENCE

#### Recommended Course Sequence

<table>
<thead>
<tr>
<th></th>
<th>Fall 16 units</th>
<th>Winter 16 units</th>
<th>Spring 14 units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sophomore</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td></td>
<td>Winter</td>
<td></td>
</tr>
<tr>
<td>CSC/CPE 205</td>
<td>4</td>
<td>(CSC/CPE 103)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(CSC/CPE 205)</td>
<td></td>
</tr>
<tr>
<td>CPE/EE 129/169</td>
<td>4</td>
<td>(CPE/CSC 101)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(CPE/EE 129/169)</td>
<td></td>
</tr>
<tr>
<td>[D4]</td>
<td>4</td>
<td>PHIL 230/231 [C2].</td>
<td>4</td>
</tr>
<tr>
<td>[D1]</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Junior</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td></td>
<td>Winter</td>
<td></td>
</tr>
<tr>
<td>CSC 300</td>
<td>4</td>
<td>(CSC/CPE 206)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(CSC/CPE 103 and CSC/CPE 250)</td>
<td></td>
</tr>
<tr>
<td>CSC/CPE 315</td>
<td>4</td>
<td>(CSC/CPE 103 and CPE 229/269)</td>
<td></td>
</tr>
<tr>
<td>[D3]</td>
<td>4</td>
<td>Math/Stat elec</td>
<td>4</td>
</tr>
<tr>
<td>[C3]</td>
<td>4</td>
<td>STAT 321 [B6]</td>
<td></td>
</tr>
<tr>
<td>[D1]</td>
<td>4</td>
<td>STAT 321 [B6]</td>
<td></td>
</tr>
<tr>
<td><strong>Senior</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td></td>
<td>Winter</td>
<td></td>
</tr>
<tr>
<td>CSC 445</td>
<td>4</td>
<td>(CSC/CPE 103)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(CSC/CPE 103 and either CSC/CPE 250 or CSC 353)</td>
<td></td>
</tr>
<tr>
<td>[C1]</td>
<td>4</td>
<td>Tech elec 3</td>
<td>4</td>
</tr>
<tr>
<td>[C4]</td>
<td>4</td>
<td>Science elec</td>
<td>4</td>
</tr>
<tr>
<td>[D1]</td>
<td>4</td>
<td>Arts &amp; humanities elec</td>
<td>4</td>
</tr>
</tbody>
</table>

Engineering support, technical elective, and GE courses need not be taken where shown.

---

1. Subject to Computer Science Department guidelines; contact the College of Engineering Advising Center (http://www.ec.calpoly.edu/CENGAC) for additional information and agreement form. Technical electives must be approved in advance.
BS COMPUTER SCIENCE

- 60 units upper division
- GWR
- 2.0 GPA
- USC

* = Satisfies General Education requirement

MAJOR COURSES

CSC 101 Fundamentals Computer Science I ........... 4
CSC 102, 103 Fund. Computer Science II, III ....... 4,4
CSC 141 Discrete Structures I ........................... 4
CPE 129, 169 Digital Design and Lab ................... 3,1
CSC 205, 206 Software Engineering I, II ............ 4,4
CPE 229, 269 Computer Design and Assembly Language Programming, and Lab .... 3,1
CSC 250 Systems Programming .......................... 4
CSC 300 Professional Responsibilities .................. 4
CSC 315 Computer Architecture .......................... 4
CSC 330 Programming Languages I ...................... 4
CSC 349 Design and Analysis of Algorithms ........... 4
CSC 445 Theory of Computing .......................... 4
CSC 453 Introduction to Operating Systems .......... 4
CSC 491, 492 Senior Project ............................. 2,3
Advisor approved technical electives ................. 24
Subject to Computer Science Department guidelines; contact the College of Engineering Advising Center (www.ee.calpoly.edu/CENGAC) for additional information and agreement form.

Technical electives must be approved in advance.

SUPPORT COURSES

BIO 213 and ENGR/BRAE 213 (B2)* ....................... 2,2
ENGL 149 Technical Writing for Engineers (A3)* .... 4
MATH 141, 142 Calculus I, II (B1)* ...................... 4,4
STAT 321 Prob/Stats for Engrs/Scientist (B6)* ....... 4
Arts and humanities elective.
- Select from GE Area C courses ........................ 4
- Society and the individual elective.
  - Select from GE Area D5 courses ............. 4
  Mathematics/statistics electives. Select from 
  8
  CSC 142; MATH 143, 206, 241, 244, 248, 306, 
  335, 336, 437, 470; STAT 322.
Science elective (Add'l Area B)* Select from 
BIO 111, 115, 151; BOT 121; CHEM 124; 
MCRO 221, 224; PHYS 131 (no double 
counting of units) .................................................. 4
Physical science electives ................................. 12
  CHEM 124 (B3/4)*, 125 (Add’l Area B)*, 129 
or 
  PHYS 131 (B3/4)*, 132 (Add’l Area B)*, 133

GENERAL EDUCATION (GE)

72 units required; 32 units are in Support.
→See page 76 for complete GE course listing.
→Minimum of 8 units required at the 300-400 level.

Area A Communication (8 units)

A1 Expository Writing ...................................... 4
A2 Oral Communication ................................... 4
A3 Reasoning, Argumentation, and Writing * 4 
  units in Support ........................................... 0

Area B Science and Mathematics (no add’l units req’d)

B1 Mathematics/Statistics * 8 units in Support...... 0
B2 Life Science * 4 units in Support .................. 0
B3 Physical Science * 4 units in Support .......... 0
B4 One lab taken with either a B2 or B3 course 
B5 (requirement for Liberal Arts students only) 
B6 Upper-division Area B * 4 units in Support ...... 0
Additional Area B units * 8 units in Support ...... 0

Area C Arts and Humanities (16 units)

C1 Literature .................................................. 4
C2 Philosophy ............................................... 4
C3 Fine/Performing Arts ................................. 4
C4 Upper-division elective ............................ 4

Area D/E Society and the Individual (16 units)

D1 The American Experience (40404) .............. 4
D2 Political Economy ....................................... 4
D3 Comparative Social Institutions ............... 4
D4 Self Development (CSU Area E) ................. 4

40

ELECTIVES .................................................. 5

186

BS SOFTWARE ENGINEERING

For course prerequisites, please refer to the “Course Descriptions” section of this catalog. In scheduling your courses each quarter, consult with your academic advisor. * Satisfies GE requirement; see page 76.

Year 1

CSC 101 Fundamentals Computer Science I ........... 4
CSC 102, 103 Fund Computer Science II, III ....... 4,4
CSC 141 Discrete Structures I ........................... 4
ENGL 134 Writing: Exposition (A1)* ................. 4
SCOM 101/102 Speech Communication (A2)* .... 4
MATH 141, 142 Calculus I, II (B1)* .................... 4,4
MATH 143 Calculus III (Add’l Area B)* ............ 4
Fine and performing arts elective (C3)* ............. 4
American experience elective (D1)* ................. 4
PSY 201/202 General Psychology (D4)* .......... 4

48

Year 2

CSC 205, 206 Software Engineering I, II .......... 4,4
CSC 305 Individual Software Design and Dev ...... 4
ENGL 149 Technical Writing for Engineers (A3)* 4
IME 314 Engineering Economics .................... 3
MATH 241 Calculus IV ................................ 4
MATH 244 Linear Analysis I .......................... 4
Philosophy elective (C2)* ............................. 4
Physical Science electives (B3/4, 4 units)*(Add’l 
units Area B)* ........................................ 12
CHEM 124, 125, 129 or PHYS 131, 132, 133 
STAT 312 Statistical Methods for Engineers (B6)* 4
Electives ........................................ 4

51

Year 3

CSC 300 Professional Responsibilities ............... 4
CSC 330 Programming Languages I .................. 4
CSC 349 Design and Analysis of Algorithms ........ 4

2003-2005 Cal Poly Catalog
CSC 353 Systems Programming for Software Engrs .................................................. 4
CSC 453 Introduction to Operating Systems ......................................................... 4
IME 430 Quality Engineering .............................................................................. 4
PSY 350 Teamwork ............................................................................................... 4
Advisor approved cooperative education experience or technical elective equivalent ........................................................................ 4
Advisor approved technical electives .................................................................. 8
Literature elective (C1)* ...................................................................................... 4
Comparative social institutions elective (D3)* .................................................. 4

Year 4
CSC 402 Software Requirements Engineering ...................................................... 4
CSC 405 Software Construction ........................................................................... 4
CSC 406 Software Deployment ............................................................................ 4
CSC 484 User-Centered Interface Design and Dev............................................. 4
CSC 491, 492 Senior Project .................................................................................. 2,3
BIO 213 and ENGR/BRAE 213 (B2)* ................................................................. 2,2
Select one from: MATH 248, 304, 333, 335, 336 .............................................. 4
Literature, philosophy, arts (300-400 level) (C4)* ................................................. 4
Political economy elective (D2)* ....................................................................... 4
Advisor approved technical electives ............................................................... 12

**SUPPORT COURSES**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO 213 and ENGR/BRAE 213 (B2)*</td>
<td>2,2</td>
</tr>
<tr>
<td>ENGL 149 Technical Writing for Engineers (A3)*</td>
<td>4</td>
</tr>
<tr>
<td>IME 314 Engineering Economics ...................................................</td>
<td>3</td>
</tr>
<tr>
<td>IME 430 Quality Engineering ................................................................</td>
<td>4</td>
</tr>
<tr>
<td>note: prerequisite waived for SE students</td>
<td></td>
</tr>
<tr>
<td>MATH 141, 142 Calculus I, II (B1)*</td>
<td>4,4</td>
</tr>
<tr>
<td>MATH 143 Calculus III (Add’l Area B)*</td>
<td>4</td>
</tr>
<tr>
<td>MATH 241 Calculus IV ..........................................................................</td>
<td></td>
</tr>
<tr>
<td>MATH 244 Linear Analysis I ..................................................................</td>
<td></td>
</tr>
<tr>
<td>Select one from: MATH 248, 304, 333, 335, 336</td>
<td>4</td>
</tr>
<tr>
<td>PSY 201/202 General Psychology (D4)*</td>
<td>4</td>
</tr>
<tr>
<td>PSY 350 Teamwork ..............................................................................</td>
<td></td>
</tr>
<tr>
<td>Science electives (B3/4)* (Add’l 4 units Area B)*</td>
<td>12</td>
</tr>
<tr>
<td>Select either</td>
<td></td>
</tr>
<tr>
<td>CHEM 124, 125, 129 or</td>
<td></td>
</tr>
<tr>
<td>PHYS 131, 132, 133</td>
<td></td>
</tr>
<tr>
<td>STAT 312 Statistical Methods for Engineers (B6)*</td>
<td>4</td>
</tr>
</tbody>
</table>

**GENERAL EDUCATION (GE)**

72 units required; 36 units are in Major/Support.
→See page 76 for complete GE course listing.
→Minimum of 8 units required at the 300-400 level.

**Area A Communication (8 units)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 Expository Writing .....................................................................</td>
<td>4</td>
</tr>
<tr>
<td>A2 Oral Communication ....................................................................</td>
<td>4</td>
</tr>
<tr>
<td>A3 Reasoning, Argumentation, and Writing *</td>
<td>4</td>
</tr>
</tbody>
</table>

**Area B Science and Mathematics (no add’l units req’d)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1 Mathematics/Statistics *</td>
<td>8</td>
</tr>
<tr>
<td>B2 Life Science *</td>
<td>4</td>
</tr>
<tr>
<td>B3 Physical Science *</td>
<td>4</td>
</tr>
<tr>
<td>B4 One lab taken with either a B2 or B3 course</td>
<td></td>
</tr>
<tr>
<td>B5 (requirement for Liberal Arts students only)</td>
<td></td>
</tr>
<tr>
<td>B6 Upper-division Area B *</td>
<td>4</td>
</tr>
<tr>
<td>Additional Area B units *</td>
<td>8</td>
</tr>
</tbody>
</table>

**Area C Arts and Humanities (16 units)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1 Literature</td>
<td>4</td>
</tr>
<tr>
<td>C2 Philosophy</td>
<td>4</td>
</tr>
<tr>
<td>C3 Fine/Performing Arts</td>
<td>4</td>
</tr>
<tr>
<td>C4 Upper-division elective</td>
<td>4</td>
</tr>
</tbody>
</table>

**Area D/E Society and the Individual (12 units)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1 The American Experience (40404)</td>
<td>4</td>
</tr>
<tr>
<td>D2 Political Economy</td>
<td>4</td>
</tr>
<tr>
<td>D3 Comparative Social Institutions</td>
<td>4</td>
</tr>
<tr>
<td>D4 Self Development (CSU Area E) *</td>
<td>4</td>
</tr>
</tbody>
</table>

**ELECTIVES**                                                          | 4     |
MS COMPUTER SCIENCE

The MS program in Computer Science offers students the opportunity to prepare for careers in several areas of emphasis including software engineering, computer architecture, programming languages, theory of computing, operating systems, database systems, distributed computing, computer networks, artificial intelligence, computer graphics, and human-computer interaction. The program is designed for maximum flexibility to allow students to concentrate in one or more areas of study.

Admission to the program requires a baccalaureate degree from an accredited institution and good standing at the last college attended. During the last 90 quarter hours of study, the student must have earned a minimum grade point average of 3.0 if the undergraduate degree is in Computer Science, or 3.25 for other degrees. A satisfactory score on the Graduate Record Exam (GRE) is required. Foreign applicants must have a minimum TOEFL score of 550 (paper-based) or 213 (computer-based), plus a minimum TWE score of 4.5. Applicants must provide three letters of recommendation. Women and underrepresented minorities are strongly encouraged to apply for admission.

Qualified students who do not have an undergraduate degree in Computer Science may be admitted as unclassified students. Unclassified students must complete the necessary undergraduate coursework to be admitted to candidacy. While fulfilling the undergraduate requirements, unclassified students retain official status as graduate students in the University.

Unclassified students may advance to candidacy by completing each of the following undergraduate courses with a "B" or better. These courses do not count toward the graduate degree:

- CSC 103 Fundamentals of Computer Science III (4)
- CSC 205 Software Engineering I (4)
- CSC 315 Computer Architecture (4)
- CSC 330 Programming Languages I (4)
- CSC 349 Design and Analysis of Algorithms (4)
- CSC 445 Theory of Computing (4)
- CSC 453 Introduction to Operating Systems (4)

The department offers several graduate teaching assistantships. Preference is given to continuing graduate students and experienced teachers. Other grant, fellowship, scholarship and loan information can be obtained from the Financial Aid office.

Degree Requirements

Students must file a formal study plan with the Computer Science Department office no later than the end of the quarter in which they complete the first unit of coursework to be counted toward the degree. The formal study plan identifies specific courses to be taken to fulfill requirements of the MS degree. The formal study plan may be amended with approval of the graduate coordinator.

The MS degree requires at least 45 units beyond the undergraduate degree. Courses must be chosen according to the following requirements:

Curriculum for MS Computer Science

Select five courses from the following: .......................... 20
CSC 508 Software Engineering I (4)
CSC 509 Software Engineering II (4)
CSC 520 Computer Architecture (4)
CSC 530 Language and Translators (4)
CSC 540 Theory of Computing II (4)
CSC 550 Operating Systems (4)
CSC 560 Database Systems (4)
CSC 569 Distributed Computing (4)
CSC 580 Artificial Intelligence III (4)

Thesis/Project and Seminar ................................. 9
CSC 590 Graduate Seminar (3)
CSC 599 Thesis (6)

Electives to be selected with Graduate Advisor's approval ............................................. 16

____ 45

For further information or advisement students should communicate with the Graduate Coordinator of the Computer Science Department.
Electrical Engineering

Department Office
Engineering East Bldg. (20), Room 200
(805) 756-2781
www.ee.calpoly.edu

Department Chair, Michael M. Cirovic
Samuel O. Agbo
William L. Ahlgren
Dean Y. Arakaki
David B. Braun
Jerome R. Breitenbach
Fred W. DePierro
Saul Goldberg
Gary Granneman
James G. Harris
Michael Hawes
William F. Horton
Martin E. Kaliski
Albert A. Liddicoat
C. Arthur MacCarley
Bryan J. Mealy
Shien-Yi Meng
Ahmad Nafisi
Mahmood Nahvi
John A. Saghi
Richard S. Sandige
Ali O. Shaban
Cheng Sun
Shyama C. Tandon
Taufik
Donley J. Winger
Michael T. Wollman
Xiao-Hua (Helen) Yu

College of Engineering Advising Center
Engineering South (40), Room 115
(805) 756-1461

ACADEMIC PROGRAMS
BS, MS Electrical Engineering
BS Computer Engineering

The department offers the BS in Electrical Engineering which is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology, and the MS in Electrical Engineering. The mission of the Electrical Engineering Department is to educate students to achieve excellence in the discipline of electrical engineering and to teach them to apply their education to solve practical problems in a socially responsible way. We seek to prepare students for careers of service, leadership, and distinction in engineering and other related fields using a participatory, learn-by-doing, and "hands-on" laboratory, project, and design-centered approach. We seek to prepare students to participate in lifelong learning in the presence of rapid technological change. The department supports interdisciplinary programs such as Computer Engineering. It welcomes diversity in the student, faculty, and staff populations. The faculty are dedicated to quality teaching and engaging in scholarly activity. Student creativity is encouraged and fostered in this environment. Thus, the primary educational objectives of the electrical engineering program are to educate graduates who:

1. excel in the profession of electrical engineering;
2. continue to expand their knowledge and skills throughout their careers, in the process of life-long learning; and
3. are readily able to pursue graduate degrees.

In addition to the general abilities expected of college of engineering graduates listed on page 188, electrical engineering students are expected to graduate with:

- a knowledge of probability and statistics, including applications appropriate to the electrical engineering field;
- a knowledge of mathematics through differential and integral calculus, basic sciences, and engineering sciences necessary to analyze and design complex devices and systems containing hardware and software components; and
- a knowledge of advanced mathematics, typically including differential equations, linear algebra, complex variables, and discrete mathematics.

The main focus of the program is to prepare graduates for practice in professional engineering. Thus, Cal Poly’s “learn by doing” philosophy is emphasized by integrating design throughout the curriculum in the numerous design-centered laboratories. In the required senior design project, students demonstrate their understanding of engineering knowledge and their ability to apply that knowledge creatively to practical problems.

The intent of the department is to prepare students for pursuing engineering solutions to urgent problems in reshaping the environment to meet human needs while being responsibly aware of all implications. The curriculum provides a sound theoretical background along with current, practical engineering knowledge. The student begins the major in the first quarter with orientation and generally has one or more major courses each quarter until graduation. The many laboratory courses provide practical experience and lead logically into design.

During their junior and senior years, students choose technical electives. Some courses deal with the development, design and application of circuits, devices and systems for communication, computers, controls, information processing and display, and system instrumentation. Senior courses in this area provide specialized preparation in a selected area such as active and passive network synthesis, advanced communications systems, computer system design, microelectronic circuit engineering, microprocessor systems applications, microwave engineering, photonics, and solid state devices. Other courses deal with industrial process control systems and with generation, distribution, control and utilization of electric power. Senior elective courses in this area provide specialized preparation in a selected area such as advanced control systems, energy conversion, power system analysis, protection and stability and solid state motor control.
Industry recognizes that students who have completed specialized technical courses are early contributors to the workforce. Students wishing to pursue graduate work may select appropriate senior courses in keeping with this goal. Laboratories are well-equipped to provide students with both hands-on instrumentation and design experiences. Involvement in faculty research is possible for outstanding students. Research areas include computer-aided education, advanced electronics for automotive and transportation applications, signal and image processing, electric vehicles, computer architecture and software systems, photonics, polymer electronics, and electric power quality.

The Electric Power Institute, sponsored by the university and underwritten by major utility companies and electrical equipment manufacturers, offers advanced seminars and lectures in the electrical power field and provides limited student and faculty exchange opportunities.

Students are encouraged to participate in professional organizations and clubs such as: Institute of Electrical and Electronics Engineers (IEEE), Audio Engineering Society (AES), IEEE Computer Society, Power Engineering Society (PES), Eta Kappa Nu (HKN), Society of Photo-Optical Instrumentation Engineers (SPIE), Student Electrical Engineering Council (SEEC), Amateur Radio Club, and Poly Phase Club. The Department supports the concept of international education and encourages students to investigate opportunities for overseas study. For further information, see the Study Abroad programs.

**BS Computer Engineering**

For information regarding this program, please refer to Computer Engineering. This program is jointly offered by the Computer Science Department and the Electrical Engineering Department.

**Blended BS + MS Electrical Engineering**

Students must be prepared for engineering practice via the curriculum which culminates in a major design experience based on the knowledge and skills acquired in earlier coursework and incorporating engineering standards and realistic constraints, as listed in the ABET Engineering Criteria. Therefore, all “Blended B.S. + M.S. Program” students, even those students completing the master of Science in Engineering, must have a master’s thesis with this major design experience requirement included in order to complete the undergraduate degree.

The blended program is an honors program that provides a means for academically excellent students to complete the MS Electrical Engineering, with simultaneous conferring of both bachelor’s and master’s degrees. Students in the blended program are provided with a seamless process whereby they can progress from undergraduate to graduate status.

**Eligibility**

Students majoring in BS Electrical Engineering or Computer Engineering may be eligible to pursue the blended program after completing all required EE/CPE 300-level courses.

Participation in the program is based on prior academic performance and other measures of professional promise. Students are selected by the Graduate Committee. See page 96 for the minimum university eligibility criteria; contact the EE Department for specific program eligibility criteria.

**Program of Study**

A feature of the program is to allow the use of a common project for fulfillment of both the Master’s Thesis (EE 599) and Senior Project (EE 461/462). A faculty advisor serves as the thesis committee chairperson and the senior project advisor. The unit requirements for either degree are unchanged. A student in this program, at his/her request, may be awarded the BS degree prior to the completion of the program, at a point when all requirements for the BS degree have been met, including an acceptable senior project report.

### BS ELECTRICAL ENGINEERING

<table>
<thead>
<tr>
<th>Recommended Course Sequence</th>
<th>(Prerequisite courses in parentheses: *=or concurrent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering support, technical elective, and GE courses need not be taken where shown.</td>
<td>[GE]</td>
</tr>
</tbody>
</table>

#### Freshman

<table>
<thead>
<tr>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 units</td>
<td>16 units</td>
<td>16 units</td>
</tr>
<tr>
<td>MATH 141 [B1]</td>
<td>MATH 142 [B1] (MATH 141)</td>
<td>MATH 143 [B] (MATH 142)</td>
</tr>
<tr>
<td>EE 111/151</td>
<td>CSC 101</td>
<td>EE 129/169 (EE 111/151, CSC 101)</td>
</tr>
<tr>
<td>CHEM 124 [B3, B4] (MATH 141, 142*)</td>
<td>PHYS 131 [B] (MATH 141, 142*)</td>
<td>PHYS 133 (PHYS 131, MATH 142)</td>
</tr>
<tr>
<td>IME 156</td>
<td>ENGL 134 [A1]</td>
<td>ENGL 149 [A3]</td>
</tr>
</tbody>
</table>

#### Sophomore

<table>
<thead>
<tr>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>17 units</td>
<td>17 units</td>
<td>16 units</td>
</tr>
<tr>
<td>MATH 244 (MATH 143)</td>
<td>MATH 241 (MATH 143)</td>
<td>PHYS 211 (PHYS 132, 133, MATH 241)</td>
</tr>
<tr>
<td>EE 213/253 (PHYS 133, MATH 244*)</td>
<td>EE 214/254 (EE 213/253, MATH 244)</td>
<td>EE 228 (EE 214/254)</td>
</tr>
<tr>
<td>PHYS 132 (PHYS 131)</td>
<td>EE 229/269 (EE 129/169)</td>
<td>EE 255/295 (EE 214/254)</td>
</tr>
<tr>
<td>BIO&amp;ENGR 213 [B2] (MATH 142, CHEM 124)</td>
<td>[C1]</td>
<td>[C2]</td>
</tr>
</tbody>
</table>

#### Junior

<table>
<thead>
<tr>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 units</td>
<td>15 units</td>
<td>16 units</td>
</tr>
<tr>
<td>EE 328/368 (EE 228)</td>
<td>EE 302/342 (EE 228, 255/295)</td>
<td>EE 329 (EE 307/347)</td>
</tr>
<tr>
<td>STAT 350 [B6] (EE 228)</td>
<td>EE 314 (STAT 350)</td>
<td>EE 335 (MATH 241, EE 214/254)</td>
</tr>
<tr>
<td>[C3]</td>
<td>[C4]</td>
<td>[D1]</td>
</tr>
</tbody>
</table>
### Technical Elective Technical Elective Technical Elective

**Engineering Support Engineering Support Engineering Support**

### EE 402/449 (EE 308/348, 328/368, 329)

- EE 402 Electromagnetic Waves
- EE 335 Electromagnetic Fields and Transmission
- EE 328 Discrete Time Signals and Systems
- EE 259, 269 Computer Design and Assembly Language Programming and Lab
- EE 229, 269 Computer Design and Assembly Language Programming and Lab
- EE 255, 295 Energy Conversion Electromagnetics and Lab
- EE 302, 342 Classical Control Systems and Lab
- EE 306, 346 Semiconductor Device Electronics and Lab
- EE 307, 347 Digital Electronics and Integrated Circuits and Lab
- EE 308, 348 Analog Electronics and Integrated Circuits and Lab
- EE 314 Introduction to Communication Systems
- EE 328 Discrete Time Signals and Systems and EE 368 Signals and Systems Laboratory
- EE 329 Programmable Logic and Microprocessor-Based Systems Design
- EE 335 Electromagnetic Fields and Transmission
- EE 402 Electromagnetic Waves
- EE 442 Electromagnetic Fields and Transmission Laboratory
- EE 409, 449 Electronic Design and Lab
- EE 460 Senior Project Preparation
- EE 461 Senior Project or EE 463 Senior Project Design Laboratory
- EE 462 Senior Project or EE 464 Senior Project Design Laboratory
- Advisor approved technical electives
- EE 460 Senior Project Preparation

### EE 461 or EE 463

- EE 461 or EE 463
- EE 462 or EE 464
- EE 461 or EE 463

### BS ELECTRICAL ENGINEERING

- 60 units upper division
- GWR
- 2.0 GPA
- USCP

* = Satisfies General Education requirement

### MAJOR COURSES

- EE 111, 151 Intro to Electrical Engineering & Lab
- EE 129, 169 Digital Design and Lab
- EE 213, 253 Basic Circuit Analysis and Lab
- EE 214, 254 Steady-State Circuit Analysis and Lab
- EE 228 Continuous-Time Signals and Systems
- EE 229, 269 Computer Design and Assembly Language Programming and Lab
- EE 255, 295 Energy Conversion Electromagnetics and Lab
- EE 302, 342 Classical Control Systems and Lab
- EE 306, 346 Semiconductor Device Electronics and Lab
- EE 307, 347 Digital Electronics and Integrated Circuits and Lab
- EE 308, 348 Analog Electronics and Integrated Circuits and Lab
- EE 314 Introduction to Communication Systems
- EE 328 Discrete Time Signals and Systems and EE 368 Signals and Systems Laboratory
- EE 329 Programmable Logic and Microprocessor-Based Systems Design
- EE 335 Electromagnetic Fields and Transmission
- EE 402 Electromagnetic Waves
- EE 442 Electromagnetic Fields and Transmission Laboratory
- EE 409, 449 Electronic Design and Lab
- EE 460 Senior Project Preparation
- EE 461 Senior Project or EE 463 Senior Project Design Laboratory
- EE 462 Senior Project or EE 464 Senior Project Design Laboratory
- Advisor approved technical electives

### ELECTIVES

- Select a minimum of 2 EE senior design laboratories and 2 EE senior design lectures.

### SUPPORT COURSES

- BIO 213 and ENGR/BRAE 213 (B2)
- CHEM 124 Gen Chem for Engineering (B3/B4)
- CSC 101 Fundamentals of Computer Science I
- ENGL 149 Technical Writing for Engineers (A3)
- IME 156 Electronic Manufacturing

### MINIMUM OF 8 UNITS REQUIRED AT THE 300-400 LEVEL.

### GENERAL EDUCATION (GE)

- 72 units required; 32 units are in Support.
- Minimum of 8 units required at the 300-400 level.

### AREA A Communication (8 units)

- A1 Expository Writing
- A2 Oral Communication
- A3 Reasoning, Argumentation, and Writing

### AREA B Science and Mathematics (with additional units required)

- B1 Mathematics/Statistics
- B2 Life Science
- B3 Physical Science
- B4 One lab taken with either B2 or B3 course
- B5 (requirement for Liberal Arts students only)

### AREA C Arts and Humanities (16 units)

- C1 Literature
- C2 Philosophy
- C3 Fine/Performing Arts
- C4 Upper-division elective

### AREA D/E Society and the Individual (16 units)

- D1 The American Experience
- D2 Political Economy
- D3 Comparative Social Institutions
- D4 Self Development (CSU Area E)

### 193 UNITS

---

*Math 141, 142 Calculus I, II (B1)*

*MATH 143 Calculus III (Add’l Area B)*

*MATH 241 Calculus IV*

*MATH 244 Linear Analysis I*

*PHYS 131 General Physics (Add’l Area B)*

*PHYS 132, 133 General Physics*

*PHYS 211 Modern Physics*

*STAT 350 Probability and Random Processes for Engineers (B6)*

Approved engineering support electives

Select at least 3 courses from list of approved courses (on file in EE Department)
MS ELECTRICAL ENGINEERING

General Characteristics
The Master of Science program in Electrical Engineering has the following objectives:

- Job-entry education for the more complex areas of engineering, such as research and development, innovative design, systems analysis and design, and managerial engineering;
- Updating and upgrading opportunities for practicing engineers;
- Graduate preparation for further study in engineering, leading to the Doctor of Engineering or Ph.D. degree;
- A base which allows graduates to maintain currency in their fields.

Prerequisites
For admission as a classified graduate student, an applicant must hold a bachelor’s degree in engineering or a closely related physical science with a minimum grade point average of 3.0 in the last 90 quarter units (60 semester units) attempted. Applicants for graduate engineering programs are required to submit satisfactory scores for the General (Aptitude) Test of the Graduate Record Examination. Foreign applicants must have satisfactory scores on the TOEFL and TWE exams. An applicant who meets these standards but lacks prerequisite coursework may be admitted as a conditionally classified student and must make up any deficiencies before advancement to classified graduate standing.

Information pertaining to specific requirements for admission to graduate standing (classified or conditionally classified) may be obtained from the Graduate Coordinator, Electrical Engineering Department.

Program of Study
Graduate students in this program must file a formal study plan with their advisor, department, college and university graduate studies office by no later than the end of the second quarter in the program. The formal program of study must include a minimum of 45 units (at least 28 of which must be at the 500 level and the remainder at the 400 level).

The broad curriculum requirements for the MS in Electrical Engineering are:

a) core of 16 units;
b) a minimum of 12 units of additional electrical engineering courses;
c) at least 17 units of approved electives;
d) at least 28 units of the 45 unit program at the 500 level.

Two program options are available for MS in Electrical Engineering students: a thesis program which requires coursework, a thesis and oral defense of thesis; or a nonthesis option which involves additional coursework and a comprehensive examination. The thesis option is strongly encouraged for all students.

Curriculum for MS Electrical Engineering
Core Courses .................................................. 16
EE 525 Stochastic Processes for Engineers (4)
EE 563 Graduate Seminar (1) (1)
EE 599 Design Project (Thesis) (1-9) units of major field graduate level courses and a comprehensive written examination

Additional Electrical Engineering Graduate Courses ................................. 12
To be selected from the following list: Not all courses listed are offered each academic year. Consult the EE Department for current information on course offerings
EE 502 Microwave Engineering (4)
EE 511 Electric Machines Theory (3)
EE 513 Control Systems Theory (4)
EE 514 Advanced Topics in Automatic Control (4)
EE 515 Discrete Time Filters (4)
EE 517 Information Theory (4)
EE 518 Advanced Power System Analysis (3)
EE 519 Power System Design (4)
EE 520 Solar-Photovoltaic Systems Design (3)
EE 521 Computer Systems (4)
EE 522 Microproc-Based Digital Sys Design (4)
EE 523 Digital Systems Design (3)
EE 524 Solid State Electronics (3)
EE 526 Digital Communications (4)
EE 527 Advanced Topics in Power Electronics (4)
EE 528 Digital Image Processing (4)
EE 529 Microwave Device Electronics (3)
EE 530 Photonics Systems (4)
EE 533 Antennas (4)
EE 541 Advanced Microwave Laboratory (2)
EE 544 Solid-State Electronics Laboratory (1)

Approved Technical Electives (400-500 level) ........ 17
May be selected from the course list above and other advisor approved technical electives.

45
General Engineering
An Interdisciplinary Curriculum in Engineering Science and Emerging Technologies

Coordinator, Daniel W. Walsh
Engineering Bldg. (13), Room 266
(805) 756-2131

College of Engineering Advising Center
Engineering South (40), Room 115
(805) 756-1461

ACADEMIC PROGRAMS

BS General Engineering

The mission of the General Engineering Program is to provide students with the highest quality technical and professional engineering education, with a particular emphasis in new or evolving interdisciplinary areas, while allowing the student to participate in designing their curricula.

The primary goal of the General Engineering Program is to provide students with a theoretically rigorous and laboratory-centered, practice-oriented, hands-on education that will allow our graduates to immediately participate and to excel in professional environments.

General Engineering graduates are expected to be ready for immediate entry into the professional engineering field. They are also expected to demonstrate an ability to satisfy their personal needs for further education, as expressed in their matriculation to graduate or professional schools in some cases, and an interest in life-long learning in all cases. They are expected to possess a solid engineering foundation which will underpin a successful career. They are expected to be leaders, based on strong communication skills, a capacity to form teams and perform in teams, and an understanding of the economic and social impact of their decisions.

In addition to the abilities expected of all engineering graduates, articulated in the section of this catalog describing the College of Engineering, General Engineering graduates are expected to leave the University with special capabilities pertinent to their own concentrations.

The Bachelor of Science degree in General Engineering is designed to allow students the latitude in course selection required to educate themselves either in the classical study of engineering or in new and evolving interdisciplinary technologies such as bioengineering and mechatronics. The degree is an excellent preparation for an applied terminal masters degree in these interdisciplinary fields such as the Blended BS+MS program described in the MS Engineering section of this catalog. General Engineering can also accommodate those students who wish to major in engineering but have not presently decided in which specific program their interest is centered. The curriculum builds a sound foundation in the fundamental principles of engineering and engineering systems during the early years of study. During their final quarters of study, students customize their study plan with the help of a faculty advisor and are given the opportunity to focus their education while still at the undergraduate level. The BS degree in General Engineering is, therefore, a direct path to employment in a classic engineering field or in an area of emerging technology. It is also a natural step toward a professional or a graduate degree.

General Engineering students are encouraged to participate in the Blended BS+MS program. This program recognizes that the expertise required of entry level engineers in many field, particularly new and evolving technological fields, implies that a masters degree is a prerequisite for success. The program allows motivated students to reduce the time necessary to earn both degrees.

All practitioners of engineering must have an understanding of the physical sciences and mathematics. Further, they must have a firm grasp of engineering sciences. The General Engineering curriculum provides the framework for this matrix of understanding, upon which the practitioner may begin to develop a unique area of expertise.

The General Engineering program focuses on synthesis, the integration of diverse elements to produce a single entity – an integral activity in the engineering profession. The Synthesis plan of study, developed with the support of the National Science Foundation, stresses integrated design, open-ended problem solving, experimentation, and manufacturing and construction. The program emphasizes phenomenological theory as well as analytical, experimental, and design skills – not in compartmentalized courses, but as a unified entity. The curriculum acccents societal context, multidisciplinary teamwork and communication skills. It also emphasizes practical applications as well as principles. The laboratories in many of the courses are constantly evolving, so students benefit from a variety of state-of-the-art equipment.

This program is for directed, highly motivated students. The technical elective courses are selected to be consistent with a sharply defined career goal. Each student will be required to submit a study plan to the coordinator prior to the end of the first quarter of their junior year. Study plans selected in the past have emphasized engineering physics, biomedical engineering, and ocean engineering. Plans that are currently popular include biochemical engineering and synthesis.

2003-2005 Cal Poly Catalog
The application of engineering to medicine and biology underpins a strong and growing segment of the industrial sector and continues to be an area of inherent interest to students. The need for well educated professionals in this area has become more acute as the technology being applied has become more sophisticated. Evolution in computing, electronics, signal analysis and mechatronic systems have been harbingers of improvement to diagnostic efforts, therapeutic approaches and bioindustrial applications. Studies of biological materials, physiological mechanisms, biochemical kinetics and heat and mass transfer in biological systems require engineering expertise. Applied medical and biological research has taken on a distinct engineering aspect.

Mechatronics, another popular student focus, is defined as the application of decision making to physical systems. Today’s engineered products are complex, composed of integrated mechanical and electronic components and operate with the aid of control software. Design and fabrication of such products requires knowledge of manufacturing, mechanical engineering, electronics and materials as well as experience with concurrent engineering tools. Embedded computers of all sizes and capabilities are used in the decision making elements of products which daily affect the lives of essentially each resident in the developed world. Microcontrollers and mechatronic systems are found in devices as mundane as lawn mowers and as esoteric as deep space probes – and every system in between.

**Biomedical Engineering Concentration.** Provides students with interdisciplinary exposure in a burgeoning field. The program highlights an immediate introduction to the major, strong personal interaction with faculty, strong partnerships with industrial participants and a signature laboratory experience. Rooted in a strong engineering exposure, the curriculum allows students to pursue applied biotechnical emphasis. Studies of biological materials, physiological mechanisms, biochemical kinetics and heat and mass transfer in biological systems require engineering expertise. Applied medical and biological research has taken on a distinct engineering aspect.

**Individualized Course of Study.** Allows students to pursue a course of study which meets their individual needs and interests. Courses are selected by the student with the advice and approval of the student’s academic advisor and department chair.

**BS GENERAL ENGINEERING**

For course prerequisites, please refer to the “Course Descriptions” section of this catalog. In scheduling your courses each quarter, consult with your academic advisor. *Satisfies GE requirement; see page 76.

**Freshman**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 110, 111, 112 Engineering Science I, II, III</td>
<td>3, 3, 3</td>
</tr>
<tr>
<td>CHEM 124 Gen Chem for Engineering (B3/B4)*</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 125 Gen Chem for Engrg (Add’l Area B)*</td>
<td>4</td>
</tr>
<tr>
<td>CSC 234/CSC 101</td>
<td>3/4</td>
</tr>
<tr>
<td>ENGL 134 Writing: Exposition (A1)*</td>
<td>4</td>
</tr>
<tr>
<td>SCOM 101/102 Speech Communication (A2)*</td>
<td>4</td>
</tr>
<tr>
<td>MATH 141, 142 Calculus I, II (B1)*</td>
<td>4, 4</td>
</tr>
<tr>
<td>MATH 143 Calculus III (Add’l Area B)*</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 131 General Physics</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 132 General Physics</td>
<td>4</td>
</tr>
</tbody>
</table>

| Total Units                                                                 | 48-49 |

**Sophomore**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE 204 Strength of Materials</td>
<td>3</td>
</tr>
<tr>
<td>EE 201 Electric Circuit Theory</td>
<td>3</td>
</tr>
<tr>
<td>MATH 241 Calculus IV</td>
<td>4</td>
</tr>
<tr>
<td>MATH 244 Linear Systems</td>
<td>4</td>
</tr>
<tr>
<td>ME 211 Engineering Statics</td>
<td>3</td>
</tr>
<tr>
<td>ME 212 Engineering Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 133 General Physics</td>
<td>4</td>
</tr>
<tr>
<td>Physical science elective</td>
<td>4</td>
</tr>
<tr>
<td>ENGL 149 Technical Writing for Engineers (A3)*</td>
<td>4</td>
</tr>
<tr>
<td>BIO 213 and ENGR/BRAE 213 (B2)*</td>
<td>2, 2</td>
</tr>
<tr>
<td>Select one of the following: MATH 344; STAT 312, 321, 350 (B6)*</td>
<td>4</td>
</tr>
<tr>
<td>American experience elective (D1)*</td>
<td>4</td>
</tr>
<tr>
<td>Comparative social institutions elective (D3)*</td>
<td>4</td>
</tr>
</tbody>
</table>

| Total Units                                                                 | 48    |

**Junior**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>IME 314 Engineering Economics</td>
<td>3</td>
</tr>
<tr>
<td>ME 302 Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>ME 313 Heat Transfer</td>
<td>3</td>
</tr>
<tr>
<td>MATE 210, 215 Materials Engineering and Lab</td>
<td>3, 1</td>
</tr>
<tr>
<td>Literature elective (C1)*</td>
<td>4</td>
</tr>
<tr>
<td>Philosophy elective (C2)*</td>
<td>4</td>
</tr>
<tr>
<td>Political economy elective (D2)*</td>
<td>4</td>
</tr>
<tr>
<td>Self development elective (CSU Area E) (D4)*</td>
<td>4</td>
</tr>
</tbody>
</table>

1 Concentration or individual course of study................................| 22 |

| Total Units                                                                 | 51    |

**Senior**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 341 Fluid Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 481, 482 Sr. Project Design Lab I, II or Sr. Project-appropriate engineering discipline</td>
<td>2, 2</td>
</tr>
</tbody>
</table>

1 A minimum of **48 units** at 300-400 level must be completed, in a concentration, individual course of study or free electives, in addition to those required in Major, Support and General Education, for a total of 60 upper division units. *Corrected 9/27/07.*
Fine and performing arts elective (C3)* ................. 4
Literature, philosophy, arts (300-400 level) (C4)* .... 4
Physical science elective ...................................... 4
1 Concentration or individual course of study .......... 18
Electives ....................................................... 9-10

46-47

194

BS GENERAL ENGINEERING
☐ 60 units upper division ☐ GWR
☐ 2.0 GPA ☐ USCP
* = Satisfies General Education requirement

MAJOR COURSES
CE 204 Strength of Materials.............................. 3
CSC 234/CSC 101 .............................................. 3/4
EE 201 Electric Circuit Theory ............................ 3
ENGR 110,111,112 Engineering Science I,II,III ...... 3,3,3
IME 314 Engineering Economics ....................... 3
MATE 210, 215 Materials Engineering and Lab ...... 3,1
ME 211 Engineering Statics ................................ 3
ME 212 Engineering Dynamics ............................ 3
ME 302 Thermodynamics ................................... 3
ME 313 Heat Transfer ....................................... 3
ME 341 Fluid Mechanics .................................... 3
ENGR 481, 482 Sr. Project Design Lab I, II or
Sr. Project-appropriate engineering discipline ..... 2,2
1 Concentration or individual course of study .......... 40

84-85

SUPPORT COURSES
BIO 213 and ENGR/BRAE 213 (B2)* .................. 2,2
CHEM 124 Gen Chem for Engineering (B3/B4)* .... 4
CHEM 125 Gen Chem for Engineering (Add’l Area B)* ......................................................... 4
ENGL 149 Technical Writing for Engineers (A3)* ... 4
MATH 141,142 Calculus I, II (B1)* ..................... 4,4
MATH 143 Calculus III (Add’l Area B)* ..... 4
MATH 241 Calculus IV ....................................... 4
MATH 244 Linear Systems .................................. 4
Select one of the following: MATH 344; STAT
312, 321, 350 (B6)* ........................................... 4
PHYS 131, 132, 133 General Physics .................... 4,4,4
Physical science electives .................................. 4,4

60

GENERAL EDUCATION (GE)
72 units required; 32 units are in Support.
See page 76 for complete GE course listing.
Minimum of 8 units required at the 300-400 level.

Area A Communication (8 units)
A1 Expository Writing ........................................ 4
A2 Oral Communication ...................................... 4
A3 Reasoning, Argumentation, and Writing * 4 units in Support .................................................. 0

Area B Science and Mathematics (no add’l units req’d)
B1 Mathematics/Statistics * 8 units in Support ...... 0
B2 Life Science * 4 units in Support ....................... 0
B3 Physical Science * 4 units in Support ............... 0

B4 One lab taken with either a B2 or B3 course
B5 (requirement for Liberal Arts students only)
B6 Upper-division Area B * 4 units in Support ...... 0
Additional Area B units * 8 units in Support ........ 0

Area C Arts and Humanities (16 units)
C1 Literature .................................................. 4
C2 Philosophy .................................................. 4
C3 Fine/Performing Arts .................................. 4
C4 Upper-division elective ................................ 4

Area D/E Society and the Individual (16 units)
D1 The American Experience (40404) .................. 4
D2 Political Economy ....................................... 4
D3 Comparative Social Institutions ..................... 4
D4 Self Development (CSU Area E) ...................... 4

40

ELECTIVES ....................................................... 9-10

194

CONCENTRATIONS OR INDIVIDUALIZED COURSE OF STUDY (select one)

Bioengineering Concentration
CSC 341 Numerical Engineering Analysis ................ 4
ENGR 450 Special Topics in Bioengineering .......... 4
IME 144 Introduction to Design and Manufacturing.. 4
MATH 344 Linear Analysis II ................................ 4
ME 326 Intermediate Dynamics ........................... 4
Select 12 units from the following: ...................... 12
BIO 431, 432, 442; CHEM 305, 371; CSC 471;
EE 336, 419; ENVE 304, 331, 421, 443; MATE
320, 330; ME 328, 329, 401, 428, 445; STAT 312,
321, 350
Advisor approved electives ............................... 8

40

Biomedical Engineering Concentration
CHEM 312 Survey of Organic Chemistry ............... 4
CHEM 313 Survey of Biochemistry and Biotechnology 5
ENGR 450 Special Topics in Bioengineering .......... 4
IME 144 Introduction to Design and Manufacturing.. 4
MATE 425 Corrosion Engineering ........................ 4
Select 12 units from the following: ...................... 12
BIO 431, 432; BOT 426; CHEM 305, 306, 371,
473, 475, CSC 473, 474; ENVE 304, 331; MATE
446; MATH 344; IME 319, 437; ME 326, 401, 422,
423, 445; PHYS 315, 323; STAT 312, 321, 350
Advisor approved electives ............................... 7

40

Individualized Course of Study ................................ 40

Technical electives. A minimum of 34 units
must be at 300-400 level.
1 A minimum of 34 units at 300-400 level must be completed, in
addition to those required in Major, Support and General Education, for
a total of 60 upper division units. Corrected 9/27/07.
Industrial & Manufacturing Engineering

Department Office
Graphic Arts Bldg. (26), Room 100
(805) 756-2341
www.ime.calpoly.edu

College of Engineering Advising Center
Engineering South (40), Room 115
(805) 756-1461

Department Chair (Position Vacant)
Sema E. Alptekin
A. Reza Pouraghahabagher
J. Kent Butler
Paul E. Rainey
Kurt Colvin
Ahmad K. Seifoddini
Mark A. Cooper
Richard A. Strahl
Tali Freed
Daniel J. Waldorf
H. Jo Anne Freeman
Donald E. White
Jose Macedo
Tao H. Yang
Unny Menon

ACADEMIC PROGRAMS

BS, MS Industrial Engineering
BS Manufacturing Engineering

The mission of the Industrial Engineering and Manufacturing Engineering Programs at Cal Poly is “to educate students for successful and distinguished careers in industrial engineering, manufacturing engineering, and related fields using a learn-by-doing approach that stresses integrated processes, appropriate technologies, and enterprise competitive advantage.”

The department focuses on programs that integrate engineering with a real concern for people. Our students study topics that lead to satisfying and productive careers, and also provide strong preparation for graduate work in many fields. Programs reflect the traditional strengths of Cal Poly through close interaction between students and faculty in classroom, laboratory, and other activities.

Department and university laboratories and computers are integrated into coursework to investigate, test, and apply theoretical principles learned in the classroom. The descriptions below provide details of the various programs.

BS Industrial Engineering

Industrial Engineering is the profession concerned with solving integrated engineering and management problems. The definition by the Institute of Industrial Engineers is as follows: “Industrial Engineering is concerned with the design, installation, and improvement of integrated systems of people, material, information, equipment, and energy by drawing upon specialized knowledge and skills in the mathematical, physical, and social sciences, together with the principles and methods of engineering analysis and design to specify, predict, and evaluate the results to be obtained from such systems.” Key objectives of industrial engineering are to improve the quality and productivity of creating and delivering goods and services and to act as the interface between technology and humans. Engineering methods and practical knowledge are used in formulating decision models for the optimum application of engineering and management principles.

The Bachelor of Science program in Industrial Engineering is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology. The following objectives have been set for students completing the Industrial Engineering Program:

1. Immediate Practice – Graduates will be ready for immediate entry into and contribution to the practice of industrial engineering or a related field by providing knowledge of contemporary issues and direct, hands-on experience with the modern tools and techniques of the discipline.

2. Solid Engineering Foundations – Graduates will have successful careers based on their ability to solve problems and make improvements through engineering design, experimentation, and application of scientific principles as well as their ability to analyze and critically evaluate their decisions.

3. Broad Education – Graduates will have careers of distinction and leadership based on their ability to communicate effectively, to contribute meaningfully to a team effort, and to understand the economic, societal, and ethical impacts of their decisions.

4. Life-Long Learning – Graduates will demonstrate the ability and desire to follow a life-long pursuit of personal fulfillment through education.

To meet these objectives, several specific outcomes have been identified for students in the Industrial Engineering Program in addition to the general abilities expected of College of Engineering graduates listed on page 188:

1. Integrated Systems Design – ability to design, develop, implement and improve integrated systems that include people, materials, information, equipment and energy.

2. Evaluate Decisions – ability to evaluate engineering decisions with respect to cost, quality, and productivity.

3. Manufacturing Processes – ability to recognize equipment, processes, and techniques used in major manufacturing industries.

Our main focus is to prepare graduates for practice in professional engineering. Thus, our “learn by doing” philosophy is emphasized in the curriculum by the large
number of design-centered laboratories, integrating design throughout the curriculum, and the senior design project capstone design experience.

In the required senior design project, which is completed in a two-quarter set of capstone courses, students demonstrate their understanding of engineering knowledge and their ability to apply that knowledge creatively to practical problems.

Graduates can choose from a challenging range of career activities: operations research and analysis, production planning and scheduling, plant design, management, human factors engineering design, data processing and analysis, measurement, quality control and reliability assurance, technical economic planning, resource conservation, productivity measurement, increasing productivity using computer integrated manufacturing techniques, robotics, and, in general, systems analysis and design. The physical, engineering, and social sciences form the broad base for these endeavors.

The program is oriented to provide graduates with the capability of producing results with a minimum of additional training. Computer firms, health care industries, banks, retail chains, farms, airlines, mines, as well as government and traditional manufacturing industries, employ graduates of this discipline. Graduates also are well prepared for successful graduate study.

BS Manufacturing Engineering
Manufacturing engineering is the profession that applies engineering analysis and methods to the production of all manufactured goods and services. The manufacturing engineer plans, develops, and optimizes the processes of production including methods of manufacture, and designs of tools and equipment for manufacturing. The emphasis is on both development and sustained operation of manufacturing systems, including computer integrated manufacturing techniques, robotics, and, in general, systems analysis and design. The physical, engineering, and social sciences form the broad base for these endeavors.

The program is oriented to provide graduates with the capability of producing results with a minimum of additional training. Computer firms, health care industries, banks, retail chains, farms, airlines, mines, as well as government and traditional manufacturing industries, employ graduates of this discipline. Graduates also are well prepared for successful graduate study.

1. **Materials and Manufacturing Processes** – understanding of the properties of materials and how the materials behave when they are altered and influenced by processes of manufacture.
2. **Design of Products** – understanding of the design of products, including an understanding of the influence of materials, geometry, and processing on the design and the ability to create design drawings and computer models and interpret dimensions, tolerances, and other engineering specifications.
3. **Business Perspective** – understanding of the relationship of manufacturing costs to profit and loss in an enterprise and of how to judge the economic consequences of design and production strategies, methods of control, and levels of automation.
4. **Basic Skills** – ability to use the basic techniques and skills necessary for manufacturing engineering practice, including ability to set up and operate equipment and measure productivity or part quality.
5. **Control of Processes** – understanding of the control of manufacturing processes, including computer-aided, automated, and statistical methods.
6. **Life-Long Learning** – Graduates will demonstrate the ability and desire to follow a life-long pursuit of personal fulfillment through education.

To meet these objectives, several specific outcomes have been identified for students in the Manufacturing Engineering Program in addition to the general abilities expected of College of Engineering graduates listed on page 188:

1. **Materials and Manufacturing Processes** – understanding of the properties of materials and how the materials behave when they are altered and influenced by processes of manufacture.
2. **Design of Products** – understanding of the design of products, including an understanding of the influence of materials, geometry, and processing on the design and the ability to create design drawings and computer models and interpret dimensions, tolerances, and other engineering specifications.
3. **Business Perspective** – understanding of the relationship of manufacturing costs to profit and loss in an enterprise and of how to judge the economic consequences of design and production strategies, methods of control, and levels of automation.
4. **Basic Skills** – ability to use the basic techniques and skills necessary for manufacturing engineering practice, including ability to set up and operate equipment and measure productivity or part quality.
5. **Control of Processes** – understanding of the control of manufacturing processes, including computer-aided, automated, and statistical methods.
6. **Life-Long Learning** – Graduates will demonstrate the ability and desire to follow a life-long pursuit of personal fulfillment through education.

To meet these objectives, several specific outcomes have been identified for students in the Manufacturing Engineering Program in addition to the general abilities expected of College of Engineering graduates listed on page 188:

1. **Materials and Manufacturing Processes** – understanding of the properties of materials and how the materials behave when they are altered and influenced by processes of manufacture.
2. **Design of Products** – understanding of the design of products, including an understanding of the influence of materials, geometry, and processing on the design and the ability to create design drawings and computer models and interpret dimensions, tolerances, and other engineering specifications.
3. **Business Perspective** – understanding of the relationship of manufacturing costs to profit and loss in an enterprise and of how to judge the economic consequences of design and production strategies, methods of control, and levels of automation.
4. **Basic Skills** – ability to use the basic techniques and skills necessary for manufacturing engineering practice, including ability to set up and operate equipment and measure productivity or part quality.
5. **Control of Processes** – understanding of the control of manufacturing processes, including computer-aided, automated, and statistical methods.
6. **Life-Long Learning** – Graduates will demonstrate the ability and desire to follow a life-long pursuit of personal fulfillment through education.

2. **Solid Engineering Foundations** – Graduates will have successful careers based on their demonstrated ability to solve problems and make improvements through engineering design, experimentation, and application of scientific principles as well as their ability to analyze and critically evaluate their decisions.

3. **Broad Education** – Graduates will have careers of distinction and leadership based on their ability to communicate effectively, to contribute meaningfully to a team effort, and to understand the economic and ethical impacts of their decisions.

4. **Life-Long Learning** – Graduates will have careers of distinction and leadership based on their ability to communicate effectively, to contribute meaningfully to a team effort, and to understand the economic and ethical impacts of their decisions.

5. **Learn By Doing** – a participatory, “hands-on” education using a laboratory-intensive, project-oriented, design-centered “learn by doing” approach.

6. **Specialized Knowledge** – specialized knowledge in one or more areas of manufacturing and an appreciation for the wealth of information and technology not learned during undergraduate study.

In the required senior design project, which is completed in a two-quarter set of capstone courses, students demonstrate their understanding of engineering knowledge and their ability to apply that knowledge creatively to practical problems.

Graduates typically work more directly with the manufacturing processes than do industrial engineers. Emphasis is placed upon application of a basic knowledge
of physics and materials. Knowledge of basic processes, mechatronics, tool design, and computer-aided manufacturing are applied directly to the problems of development and sustained operation of manufacturing systems.

Graduates are prepared for job-entry at the professional level in the areas of CAD/CAM, process engineering, mechatronics, quality assurance, and production engineering. They also are well prepared for successful graduate study.

**Blended BS+MS Engineering Program**

Students must be prepared for engineering practice via the curriculum which culminates in a major design experience based on the knowledge and skills acquired in earlier coursework and incorporating engineering standards and realistic constraints, as listed in the ABET Engineering Criteria. Therefore, all “Blended BS + MS Program” students, even those students completing the Master of Science in Engineering, must have a master’s thesis with this major design experience requirement included in order to complete the undergraduate degree.

Students may be eligible to pursue the blended program toward the MS Engineering with a specialization in Integrated Technology Management. Please refer to the MS Engineering section of this catalog for more information and page 96 for eligibility criteria for blended programs.

**GRADUATE PROGRAMS**

The Industrial and Manufacturing Engineering Department participates in offering the following graduate programs:
- MS Industrial Engineering
- MS Engineering with specialization in Integrated Technology Management
- Joint MBA/MS Engineering with specialization in Engineering Management

**BS INDUSTRIAL ENGINEERING**

For course prerequisites, please refer to the "Course Descriptions" section of this catalog. In scheduling your courses each quarter, consult with your academic advisor. * Satisfies GE requirement; see page 76.

**Freshman**

- IME 101 Intro Industrial/Manufacturing Engr........ 1
- IME 141 Manufacturing Processes: Net Shape........ 1
- IME 223 Work Design and Measurement............... 4
- IME 144 Intro Design and Manufacturing............. 4
- CHEM 124 Gen Chem for Engineering (B3/B4)*........ 4
- CHEM 125 Gen Chem for Engineering.................. 4
- CSC 234/CSC 111............................................. 3
- ENGL 134 Writing: Exposition (A1)*................ 4
- SCOM 101/102 Speech Communication (A2)*......... 4
- MATH 141, 142 Calculus I, II (B1)*................ 4,4
- MATH 143 Calculus III (Add’l Area B)*............ 4
- American experience elective (D1)*.................. 4
- Self development elective (CSU Area E) (D4)*...... 4

**Sophomore**

- IME 239 Industrial Costs and Controls............. 3
- IME 251 Manufacturing Engineering Analysis...... 4
- IME 314 Engineering Economics.................... 3
- MATH 241 Calculus IV.................................... 4
- MATH 244 Linear Analysis I......................... 4
- ME 211 Engineering Statics........................... 3
- ME 212 Engineering Dynamics........................ 3
- ENGL 149 Technical Writing for Engineers (A3)* 4
- BIO 213 and ENGR/ENGR 213 (B2)*............... 2,2
- PHYS 131 General Physics (Add’l Area B)*........ 4
- PHYS 132, 133 General Physics....................... 4,4
- Political economy elective (D2)*................... 4
- Philosophy elective (C2)*............................. 4
- Literature elective (C1)*.............................. 4

**Junior**

- IME 301, 305 Operations Research I, II............. 4,4
- IME 312 Data Management and System Design..... 4
- IME 319 Human Factors Engineering............... 3
- IME 326 Engineering Test Design and Analysis..... 4
- IME 335 Computer-Aided Manufacturing I
  or IME 336 Manufacturing Automation............ 4
- IME 421 Manufacturing Organizations............... 3
- CE 204 Strength Materials/ME 341 Fluid Mech...... 3
- EE 201 Electric Circuits Theory..................... 3
- EE 321 Electronics....................................... 3
- MATE 210 Materials Engr/ME 302 Thermodyn...... 3
- STAT 312 Statistical Methods for Engineers (B6)* 4

1  Technical electives................................. 8

**Senior**

- IME 407 Operations Research III................... 4
- IME 410 Inventory Control Systems................ 4
- IME 420 Simulation and Expert Systems............ 4
- IME 429 Ergonomics Lab................................ 1
- IME 430 Quality Engineering......................... 4
- IME 441 Engineering Supervision I.................. 1
- IME 443 Facilities Planning and Design............ 4
- IME 481, 482 Sr Project Design Laboratory I, II .. 2,3
- Fine and performing arts elective (C3)*............ 4
- Literature, philosophy, arts (300-400 level) (C4)* 4
- Comparative social institutions elective (D3)*.... 4

1  Technical electives................................. 6

**Total**

- 49

1  Advisor approved technical electives.
BS INDUSTRIAL ENGINEERING

- 60 units upper division
- GWR
- 2.0 GPA
- USCP

* = Satisfies General Education requirement

MAJOR COURSES
IME 101 Intro Industrial & Manufacturing Engr...... 1
IME 141 Manufacturing Processes: Net Shape...... 1
IME 144 Intro Design and Manufacturing.............. 4
IME 223 Work Design and Measurement.............. 4
IME 239 Industrial Costs and Controls.............. 3
IME 251 Manufacturing Engineering Analysis....... 4
IME 301, 305 Operations Research I, II ............... 4,4
IME 312 Data Management and System Design....... 4
IME 314 Engineering Economics......................... 3
IME 319 Human Factors Engineering.................... 3
IME 326 Engineering Test Design and Analysis....... 4
IME 335 Computer-Aided Manufacturing I
    or IME 356 Manufacturing Automation............ 4
IME 407 Operations Research III ....................... 4
IME 410 Inventory Control Systems................... 4
IME 420 Simulation and Expert Systems.............. 4
IME 421 Manufacturing Organizations............... 3
IME 429 Ergonomics Lab...................................... 1
IME 430 Quality Engineering............................ 4
IME 441 Engineering Supervision I.................... 1
IME 443 Facilities Planning and Design.............. 4
IME 481, 482 Sr Project Design Laboratory I, II.... 2,3

1 Technical electives ..................................... 14

1  Advisor approved technical electives.

SUPPORT COURSES
BIO 213 and ENGR/BRAE 213 (B2)*....................... 2,2
CE 204 Strength Materials/ME 341 Fluid Mech...... 3
CHEM 124 Gen Chem for Engineering (B3/B4)*....... 4
CHEM 125 Gen Chem for Engineering................... 4
CSC 234/CSC 111............................................... 3
EE 201 Electric Circuits Theory....................... 3
EE 321 Electronics............................................ 3
ENGL 149 Technical Writing for Engineers (A3)*... 4
MATH 141, 142 Calculus I, II (B1)*................. 4,4
MATH 143 Calculus III (Add’l Area B)*............ 4
MATH 241 Calculus IV......................................... 4
MATH 244 Linear Analysis I................................. 4
ME 211 Engineering Statics.............................. 3
ME 212 Engineering Dynamics........................... 3
ME 302 Thermodyn/MATE 210 Materials Engr......... 3
PHYS 131 General Physics (Add’l Area B)*........... 4
PHYS 132, 133 General Physics.......................... 4,4
STAT 312 Stat. Methods for Engineers (B6)*........ 4

87

GENERAL EDUCATION (GE)
72 units required; 32 units are in Support.
→See page 76 for complete GE course listing.
→Minimum of 8 units required at the 300-400 level.

Area A Communication (8 units)
A1 Expository Writing ......................................... 4
A2 Oral Communication ......................................... 4
A3 Reasoning, Argumentation, and Writing * 4 units in Support................................................. 0

Area B Science and Mathematics (no addl units reqd)
B1 Mathematics/Statistics * 8 units in Support........ 0
B2 Life Science * 4 units in Support..................... 0
B3 Physical Science * 4 units in Support................. 0
B4 One lab taken with either a B2 or B3 course
B5 (requirement for Liberal Arts students only)
B6 Upper-division Area B * 4 units in Support....... 0
Additional Area B units * 8 units in Support........ 0

Area C Arts and Humanities (16 units)
C1 Literature ........................................................ 4
C2 Philosophy ....................................................... 4
C3 Fine/Performing Arts ........................................ 4
C4 Upper-division elective ................................... 4

Area D/E Society and the Individual (16 units)
D1 The American Experience (40404) ................. 4
D2 Political Economy ............................................ 4
D3 Comparative Social Institutions.................... 4
D4 Self Development (CSU Area E) ....................... 4

40

ELECTIVES .......................................................... 0

200

73
**BS MANUFACTURING ENGINEERING**

For course prerequisites, please refer to the "Course Descriptions" section of this catalog. In scheduling your courses each quarter, consult with your academic advisor. * Satisfies GE requirement; see page 76.

**Freshman**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>IME 101 Intro to Industrial and Mfg Engineering</td>
<td>1</td>
</tr>
<tr>
<td>IME 141 Manufacturing Processes: Net Shape</td>
<td>1</td>
</tr>
<tr>
<td>IME 142 Manufacturing Processes: Materials Joining</td>
<td>2</td>
</tr>
<tr>
<td>IME 144 Introduction to Design and Manufacturing</td>
<td>4</td>
</tr>
<tr>
<td>IME 157 Electronics Manufacturing</td>
<td>4</td>
</tr>
<tr>
<td>IME 223 Work Design and Measurement</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 124 Gen Chem for Engineering (B3/B4)*</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 125 Gen Chem for Engineering</td>
<td>4</td>
</tr>
<tr>
<td>CSC 234 C and UNIX</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 134 Writing: Exposition (A1)*</td>
<td>4</td>
</tr>
<tr>
<td>SCOM 101/102 Speech Communication (A2)*</td>
<td>4</td>
</tr>
<tr>
<td>MATH 141, 142 Calculus I, II (B1)*</td>
<td>4</td>
</tr>
<tr>
<td>MATH 143 Calculus III (Add’l Area B)*</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 131 General Physics (Add’l Area B)*</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total Freshman</strong></td>
<td><strong>51</strong></td>
</tr>
</tbody>
</table>

**Sophomore**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>IME 241 Process Design I</td>
<td>4</td>
</tr>
<tr>
<td>CE 204 Strength of Materials</td>
<td>3</td>
</tr>
<tr>
<td>MATE 210, 215 Materials Engineering and Lab</td>
<td>3,1</td>
</tr>
<tr>
<td>MATH 241 Calculus IV</td>
<td>4</td>
</tr>
<tr>
<td>MATH 244 Linear Analysis I</td>
<td>4</td>
</tr>
<tr>
<td>ME 211 Engineering Statics</td>
<td>3</td>
</tr>
<tr>
<td>ME 212 Engineering Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 149 Technical Writing for Engineers (A3)*</td>
<td>4</td>
</tr>
<tr>
<td>BIO 213 and ENGR/BRAE 213 (B2)*</td>
<td>2,2</td>
</tr>
<tr>
<td>PHYS 132, 133 General Physics</td>
<td>4,4</td>
</tr>
<tr>
<td>STAT 312 Statistical Methods for Engineers (B6)*</td>
<td>4</td>
</tr>
<tr>
<td>Fine and performing arts elective (C3)*</td>
<td>4</td>
</tr>
<tr>
<td>Political economy elective (D2)*</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total Sophomore</strong></td>
<td><strong>53</strong></td>
</tr>
</tbody>
</table>

**Junior**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>IME 314 Engineering Economics</td>
<td>3</td>
</tr>
<tr>
<td>IME 335 Computer-Aided Manufacturing I</td>
<td>4</td>
</tr>
<tr>
<td>IME 341 Tool Engineering I</td>
<td>4</td>
</tr>
<tr>
<td>IME 342 Manufacturing Systems Integration</td>
<td>3</td>
</tr>
<tr>
<td>IME 352 Manufacturing Process Design II</td>
<td>4</td>
</tr>
<tr>
<td>IME 356 Manufacturing Automation</td>
<td>4</td>
</tr>
<tr>
<td>EE 201, 251 Electric Circuits Theory and Lab</td>
<td>3,1</td>
</tr>
<tr>
<td>EE 321 Electronics</td>
<td>3</td>
</tr>
<tr>
<td>ME 302 Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>American experience elective (D1)*</td>
<td>4</td>
</tr>
<tr>
<td>Literature elective (C1)*</td>
<td>4</td>
</tr>
<tr>
<td>Comparative social institutions elective (D3)*</td>
<td>4</td>
</tr>
<tr>
<td>Technical electives</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total Junior</strong></td>
<td><strong>52</strong></td>
</tr>
</tbody>
</table>

**Senior**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>IME 326 Engineering Test Design and Analysis</td>
<td>4</td>
</tr>
<tr>
<td>IME 418 Product-Process Design</td>
<td>4</td>
</tr>
<tr>
<td>IME 430 Quality Engineering</td>
<td>4</td>
</tr>
<tr>
<td>IME 455 Mfg Design and Implementation I</td>
<td>3</td>
</tr>
<tr>
<td>IME 481, 482 Sr. Project Design Laboratory I, II</td>
<td>2,3</td>
</tr>
<tr>
<td>Philosophy elective (C2)*</td>
<td>4</td>
</tr>
<tr>
<td>Literature, philosophy, arts (300-400 level) (C4)*</td>
<td>4</td>
</tr>
<tr>
<td>Self development elective (CSU Area E) (D4)*</td>
<td>4</td>
</tr>
<tr>
<td>Technical electives</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total Senior</strong></td>
<td><strong>40</strong></td>
</tr>
</tbody>
</table>

1 Technical electives

---

1 Advisor approved technical electives.
## BS MANUFACTURING ENGINEERING

- 60 units upper division
- GWR
- 2.0 GPA
- USCP

* = Satisfies General Education requirement

### MAJOR COURSES

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>IME 101</td>
<td>Introduction to Industrial and Manufacturing Engineering</td>
<td>1</td>
</tr>
<tr>
<td>IME 141</td>
<td>Manufacturing Processes: Net Shape</td>
<td>1</td>
</tr>
<tr>
<td>IME 142</td>
<td>Manufacturing Processes: Materials Joining</td>
<td>2</td>
</tr>
<tr>
<td>IME 143</td>
<td>Intro Design and Manufacturing</td>
<td>4</td>
</tr>
<tr>
<td>IME 147</td>
<td>Electronics Manufacturing</td>
<td>4</td>
</tr>
<tr>
<td>IME 223</td>
<td>Work Design and Measurement</td>
<td>4</td>
</tr>
<tr>
<td>IME 241</td>
<td>Process Design I</td>
<td>4</td>
</tr>
<tr>
<td>IME 314</td>
<td>Engineering Economics</td>
<td>3</td>
</tr>
<tr>
<td>IME 326</td>
<td>Engineering Test Design and Analysis</td>
<td>4</td>
</tr>
<tr>
<td>IME 335</td>
<td>Computer-Aided Manufacturing</td>
<td>4</td>
</tr>
<tr>
<td>IME 341</td>
<td>Tool Engineering</td>
<td>4</td>
</tr>
<tr>
<td>IME 342</td>
<td>Manufacturing Systems Integration</td>
<td>3</td>
</tr>
<tr>
<td>IME 352</td>
<td>Manufacturing Process Design II</td>
<td>4</td>
</tr>
<tr>
<td>IME 356</td>
<td>Manufacturing Automation</td>
<td>4</td>
</tr>
<tr>
<td>IME 418</td>
<td>Product-Process Design</td>
<td>4</td>
</tr>
<tr>
<td>IME 430</td>
<td>Quality Engineering</td>
<td>4</td>
</tr>
<tr>
<td>IME 455</td>
<td>Manufacturing Design and Implementation I</td>
<td>3</td>
</tr>
<tr>
<td>IME 481, 482</td>
<td>Senior Project Design Lab</td>
<td>1,2,3</td>
</tr>
</tbody>
</table>

1 Technical electives ................................................... 16

**Total:** 78

### SUPPORT COURSES

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO 213, ENGR/BRAE 213</td>
<td>(B2)*</td>
<td>2,2</td>
</tr>
<tr>
<td>CE 204</td>
<td>Strength of Materials</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 124</td>
<td>Gen Chem for Engineering (B3/B4)*</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 125</td>
<td>Gen Chem for Engineering</td>
<td>4</td>
</tr>
<tr>
<td>CSC 234</td>
<td>C and UNIX</td>
<td>3</td>
</tr>
<tr>
<td>EE 201</td>
<td>Electric Circuits Theory</td>
<td>3</td>
</tr>
<tr>
<td>EE 251</td>
<td>Electric Circuits Lab</td>
<td>1</td>
</tr>
<tr>
<td>EE 321</td>
<td>Electronics</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 149</td>
<td>Technical Writing for Engineers (A3)*</td>
<td>4</td>
</tr>
<tr>
<td>MATE 210</td>
<td>Materials Engineering</td>
<td>3</td>
</tr>
<tr>
<td>MATE 215</td>
<td>Materials Engineering Lab</td>
<td>1</td>
</tr>
<tr>
<td>MATH 141, 142</td>
<td>Calculus I, II (B1)*</td>
<td>4,4</td>
</tr>
<tr>
<td>MATH 143</td>
<td>Calculus III (Add’l Area B)*</td>
<td>4</td>
</tr>
<tr>
<td>MATH 241</td>
<td>Calculus IV</td>
<td>4</td>
</tr>
<tr>
<td>MATH 244</td>
<td>Linear Analysis I</td>
<td>4</td>
</tr>
<tr>
<td>ME 211</td>
<td>Engineering Statics</td>
<td>3</td>
</tr>
<tr>
<td>ME 212</td>
<td>Engineering Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>MATH 302</td>
<td>Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 131</td>
<td>General Physics (Add’l Area B)*</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 132, 133</td>
<td>General Physics</td>
<td>4,4</td>
</tr>
<tr>
<td>STAT 312</td>
<td>Stat. Methods for Engineers (B6)*</td>
<td>4</td>
</tr>
</tbody>
</table>

**Total:** 78

### ELECTIVES

**Total:** 0

---

### GENERAL EDUCATION (GE)

- 72 units required; 32 units are in Support.
- →See page 76 for complete GE course listing.
- →Minimum of 8 units required at the 300-400 level.

#### Area A Communication (8 units)

- A1 Expository Writing ........................................... 4
- A2 Oral Communication .......................................... 4
- A3 Reasoning, Argumentation, and Writing * 4
  units in Support................................................... 0

#### Area B Science and Mathematics (no additional units required)

- B1 Mathematics/Statistics * 8 units in Support......... 0
- B2 Life Science * 4 units in Support.................... 0
- B3 Physical Science * 4 units in Support ............. 0
- B4 One lab taken with either a B2 or B3 course
  B5 (requirement for Liberal Arts students only)
- B6 Upper-division Area B * 4 units in Support ..... 0
  Additional area units * 8 units in Support........... 0

#### Area C Arts and Humanities (16 units)

- C1 Literature ................................................... 4
- C2 Philosophy .................................................. 4
- C3 Fine/Performing Arts .................................... 4
- C4 Upper-division elective ................................ 4

#### Area D/E Society and the Individual (16 units)

- D1 The American Experience (40404) ..................... 4
- D2 Political Economy ......................................... 4
- D3 Comparative Social Institutions ..................... 4
- D4 Self Development (CSU Area E) ....................... 4

**Total:** 40

1 Advisor approved technical electives. Select courses from the list below.

All but 4 units must be upper division engineering courses. IME 301, 303, 312, 313, 319, 336, 351, 357, 410, 411, 413, 416, 417, 421, 427, 428, 429, 431, 443; MATE 230/235, MATE 410/415, MATE 430/435, MATE 440/445; ME 328, ME 341; CE 205, CE 206; BUS 487; IT 327 or current list.
MS INDUSTRIAL ENGINEERING

General Characteristics
The Master of Science program in Industrial Engineering has the following objectives:

- To help California industries in meeting their needs with respect to processes of design, optimization, and re-engineering and in competing globally, by educating and training engineers with advanced practical knowledge in the field of Industrial Engineering.

- To attract undergraduate engineers of all majors and provide education in the planning, engineering, optimization, and management of processes using the appropriate tools of Industrial Engineering.

- To further the mission and goals of the College of Engineering at Cal Poly with respect to graduate engineering education by maintaining a balance between undergraduate and graduate educational opportunities in engineering that optimally supports the health of California industry.

Each student is strongly encouraged to work with a particular faculty member in selecting a thesis topic which is of personal interest to the student and the faculty member, and to choose a substantial number of elective courses that will support the issues addressed in the thesis or project.

Prerequisites
Students with earned undergraduate degrees in any engineering major are eligible for admission. A minimum grade point average of 3.0 in the last 90-quarter units (60 semester units) is required for admission.

All candidates seeking admission to the MSIE program are required to secure a minimum score in the GRE - General Test, as prescribed by the IME Department.

Program of Study
Graduate students must file a formal study plan with their advisor, department, college and the university graduate studies office by no later than the end of the quarter in which the 12th unit of approved courses is completed. The formal program of study must include a minimum of 45 units, of which a) at least 23 units must be at the 500 level; b) at least 24 units must be in the degree major with at least 18 units at the 500 level.

The broad curriculum requirements for the program are:

- a core of 21 units
- a comprehensive written examination (non-thesis option) or an oral defense examination (theses option)
- a minimum of 24 units of advisor approved electives

Curriculum for MS Industrial Engineering

Core Courses ................................................................. 21
- IME 503 Applied Statistical Methods in Industrial Engineering (4)
- IME 541 Advanced Operations Research (4)
- IME 545 Advanced Topics in Simulation (4)
- IME 599 Design Project (Thesis) (9) or additional 9 units of advisor approved electives (non-thesis option) and Comprehensive Examination

Advisor approved electives................................................. 24

Potential electives include:
- BUS 412 Advanced Managerial Accounting (4)
- IME 409 Economic Decision Systems (3)
- IME 411 Production Systems Analysis (3)
- IME 418 Product-Process Design (4)
- IME 427 Process Optimization through Designed Experiments (4)
- IME 431 Supplier Quality Engineering (4)
- IME 500 Individual Study (1-3) (up to a maximum of 6 units)
- IME 516 Mechatronics Systems Analysis (4)
- IME 520 Advanced Information Systems for Operations (4)
- IME 526 Advanced Topics in Manufacturing System Design (4)
- IME 542 Reliability Engineering II (4)
- IME 543 Advanced Human Factors (4)
- IME 544 Advanced Topics in Engineering Economy (4)
- IME 555 Computer-Integrated Manufacturing (4)
- IME 556 Technological Project Management (4)
- IME 559 Engineering Research and Development (4)
- IME 560 Quality Engineering (4)
- IME 570 Selected Advanced Topics (1-3)
- IME 580 Manufacturing Systems (4)

_________ 45
Materials Engineering

Department Office
Air Conditioning Engrg Bldg. (12), Rm 107-H
(805) 756-2568     FAX: (805) 756-2299
www.mate.calpoly.edu
email: matedept@calpoly.edu

Department Chair, Linda Vanasupa
Katherine C. Chen          David Niebuhr
Lanny Griffin            Paul E. Rainey
Blair London              Daniel W. Walsh
Anny Morrobel-Sosa

ACADEMIC PROGRAMS

BS Materials Engineering

Materials engineering is a field in which engineers use their knowledge of the relationship between a material’s structure and its properties in order to alter the structure to get the properties that are needed. Materials engineers contribute their expertise in virtually all areas of technology: from the nano-sized materials found in biomedical and microelectronic applications to the large-scale composites found in aerospace applications.

Because engineered products are often limited by materials issues (such as performance and manufacturability), materials engineers play a vital role on engineering design teams, working closely with other engineers. As part of these teams, they apply their knowledge of science, engineering, and state-of-the-art analytical instruments.

The majority of our graduates find employment in the biomedical, electronic, aerospace and petroleum industries. Some work as consultants for large or small organizations. Others become executives. A significant number of materials engineers are involved in research and development. Many of our graduates are entrepreneurs who have started their own consulting or manufacturing companies. Others are attorneys or physicians. Because of our broad-based curriculum, our graduates are able to excel in professions of their choosing.

The curriculum in materials engineering emphasizes practical applications as well as principles. The laboratories are constantly evolving, and our students benefit from frequent exposure to a wide variety of materials testing and analysis equipment. The program is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology. Our students have a reputation for being immediately productive in industry, and they are also actively sought by graduate programs throughout the country.

Program Mission and Goals

The mission of the materials engineering program is to create and sustain an integrated, effectual engineering learning environment that develops students into educated and effective members of society.

Our primary goal is to provide students with a theoretically rigorous and “hands on” practice-oriented education that will enable graduates to be immediately productive in their careers. To attain this goal, the educational objectives of the program are to enable graduates to

1. Apply materials engineering principles to analyze and solve real-world engineering challenges.
2. Communicate and perform as effective engineering professionals in both individual and team-based project environments.
3. Work in an individual or team environment in a socially responsible manner.

Graduate Study

Graduates of the materials engineering program are qualified for admission to Cal Poly’s Master’s Degree Programs in Engineering with a Specialization in Materials. The opportunity also exists for advanced students to begin graduate study in these areas prior to completion of the BS degree, via a “blended 4+1” program. This opportunity provides a number of advantages to qualified students, and makes it possible for completion of both the BS and MS degrees in as little as 5 years. Materials engineering students participating in a blended 4+1 program are permitted to fulfill the materials senior project requirement with the master’s degree thesis. Because of the design emphasis of the senior project, a master’s thesis used to satisfy the senior project requirement must include a major engineering design experience. The thesis supervisor will assist the student in ensuring that this requirement is met. Further details are provided in the graduate study sections for each of these programs.
BS MATERIALS ENGINEERING

For course prerequisites, please refer to the “Course Descriptions” section of this catalog. In scheduling your courses each quarter, consult with your academic advisor. * Satisfies GE requirement; see page 76.

Freshman

MATE 110 Introduction to Materials Engineering........ 1
MATE 120 Intro to Materials Engineering Practice ...... 1
CHEM 124 Gen Chem for Engineering (B3/B4)* ....... 4
CHEM 125 Gen Chem for Engineering ................. 4
CSC 101/234/231 .............................................. 4/3/2
ENGL 134 Writing: Exposition (A1)* ................. 4
SCOM 101/102 Speech Communication (A2)* ....... 4
ENGL 149 Technical Writing for Engineers (A3)* ... 4
MATH 141, 142 Calculus I, II (B1)* ..................... 4,4
MATH 143 Calculus III (Add’l Area B)* .......... 4
PHYS 131 General Physics (Add’l Area B)* ....... 4
PHYS 132 General Physics ................................... 4
1 Engr Drawing/Manufacturing processes electives ... 4

Sophomore

MATE 210, 215 Materials Engineering and Lab ......... 3,1
MATE 220, 225 Structure of Materials and Lab ...... 3,1
MATE 230, 235 Physical Metallurgy and Lab ....... 4,1
CE 204 Strength of Materials ............................ 3
EE 201, 251 Electric Circuits Theory and Lab ....... 4,1
MATH 241 Calculus IV .................................... 4
MATH 244 Linear Analysis I ............................... 4
ME 211 Engineering Statics ................................ 3
ME 212 Engineering Dynamics ................................ 3
PHYS 133 General Physics .................................. 4
STAT 312 Statistical Methods for Engineers (B6)* ... 4
American experience elective (D1)* ................ 4
Philosophy elective (C2)* .................................. 4

Junior

MATE 310 Polymers ........................................... 4
MATE 320 Ceramics .......................................... 4
MATE 330 Composites ........................................ 4
MATE 340, 345 Electronic Prop Materials/Lab ....... 3,1
MATE 350, 355 Mech Behavior Materials/Lab ...... 3,2
MATE 360 Thermodynamics of Materials ............. 4
MATE 370 Kinetics of Materials .......................... 4
MATE 375 Thermodynamics and Kinetics of Materials Laboratory ........................................ 4
CE 205, 206 Strength of Materials and Lab ........... 2,1
ME 313 Heat Transfer or ME 302 Thermodynamics .. 3
CHEM 305 Physical Chemistry ............................. 4
Political economy elective (D2)* ..................... 4
Literature elective (C1)* ................................... 4
Comparative social institutions elective (D3)* ...... 4

Senior

Select at least one course from each of 3 areas: ...... 19

Materials Processing: MATE 430/435/440/445
Special Topics: MATE 446/460/510/515/518/520/525/530/540/562/570/580

MATE 467, 468 Senior Project Design Lab.......... 1,4
MATE 463 Undergraduate Seminar ................. 1
BIO 213 and ENGR/BRAE 213 (B2)* ................. 2,2
Math/Science elective (200-400 level) .............. 4
IME 314 Engineering Economics (or IME 326) ... 3
Fine and performing arts elective (C3)* ............. 4
Literature, philosophy, arts (300-400 level) (C4)* ... 4
Self development elective (CSU Area E) (D4)* .... 4
Electives ......................................................... 4

MAJOR COURSES

☐ 60 units upper division ☐ GWR
☐ 2.0 GPA ☐ USCP
* = Satisfies General Education requirement

MATE 110 Intro to Materials Engineering ............... 1
MATE 120 Intro. to Materials Engr Practice ........... 1
MATE 210, 215 Materials Engineering and Lab ....... 3,1
MATE 220, 225 Structure of Materials and Lab ...... 3,1
MATE 230, 235 Physical Metallurgy and Lab ....... 4,1
MATE 310 Polymers ........................................... 4
MATE 320 Ceramics .......................................... 4
MATE 330 Composites ........................................ 4
MATE 340, 345 Electronic Prop Materials and Lab .... 3,1
MATE 350, 355 Mech Behavior Materials and Lab ... 3,2
MATE 360 Thermodynamics of Materials .............. 4
MATE 370 Kinetics of Materials .......................... 4
MATE 375 Thermodynamics and Kinetics of Materials Laboratory ........................................ 1
MATE 467, 468 Senior Project Design Lab .......... 1,4
MATE 463 Undergraduate Seminar ................... 1
Select at least one course from each area: .......... 19
Materials Processing: MATE 430/435/440/445
Special Topics: MATE 446/460/510/515/518/520/525/530/540/562/570/580

SUPPORT COURSES

BIO 213 and ENGR/BRAE 213 (B2)* .................... 2,2
CE 204 Strength of Materials ............................ 3
CE 205, 206 Strength of Materials and Lab ...... 2,1
CHEM 124 Gen Chem for Engineering (B3/B4)* ... 4
CHEM 125 Gen Chem for Engineering ............... 4
CHEM 305 Physical Chemistry ............................. 3
CSC 101/234/231 .............................................. 4/3/2
EE 201, 251 Electric Circuits Theory and Lab ....... 3,1
ENGL 149 Technical Writing for Engineers (A3)* ... 4

1 Choose either IME 144 or a combination of ME 151 and one of IME 141, 142, 143, or IT 341, 302.
IME 314 Engineering Economics (or IME 326)...... 3
MATH 141, 142 Calculus I, II (B1) * ................. 4,4
MATH 143 Calculus III (Add’l Area B)*.............. 4
MATH 241 Calculus IV ........................................ 4
MATH 244 Linear Analysis I ............................... 4
ME 211 Engineering Statics.................................. 3
ME 212 Engineering Dynamics ........................... 3
ME 313 Heat Transfer or ME 302 Thermody..... 3
PHYS 131 General Physics (Add’l Area B)* ........ 4
PHYS 132, 133 General Physics .......................... 4,4
Math/Science elective (200-400 level)............... 4
\(^1\) Engineering Drawing and Manufacturing elective... 4
STAT 312 Statistical Methods for Engineers (B6)* 4

**GENERAL EDUCATION (GE)**
72 units required; 32 units are in Support.

→ See page 76 for complete GE course listing.
→ Minimum of 8 units required at the 300-400 level.

**Area A Communication (8 units)**
A1 Expository Writing ........................................ 4
A2 Oral Communication ....................................... 4
A3 Reasoning, Argumentation, and Writing * 4 units in Support .................................................. 0

**Area B Science and Mathematics (no additional units required)**
B1 Mathematics/Statistics * 8 units in Support .... 0
B2 Life Science * 4 units in Support...................... 0
B3 Physical Science * 4 units in Support............... 0
B4 One lab taken with either a B2 or B3 course
B5 (requirement for Liberal Arts students only)
B6 Upper-division Area B * 4 units in Support ........ 0
Additional Area B units* 8 units in Support ........ 0

**Area C Arts and Humanities (16 units)**
C1 Literature ..................................................... 4
C2 Philosophy .................................................... 4
C3 Fine/Performing Arts .................................... 4
C4 Upper-division elective ............................... 4

**Area D/E Society and the Individual (16 units)**
D1 The American Experience (40404) ............. 4
D2 Political Economy ......................................... 4
D3 Comparative Social Institutions .................. 4
D4 Self Development (CSU Area E) ................. 4

\[\text{40}\]

**ELECTIVES** .................................................. 3-5
\[\text{202}\]

\(^1\) Choose either IME 144 or a combination of ME 151 and one of IME 141, 142, 143, or IT 341, 302.
Mechanical Engineering

Department Office
Engineering Bldg. (13), Room 254
(805) 756-1334
www.me.calpoly.edu

College of Engineering Advising Center
Engineering South (40), Room 115
(805) 756-1461

Department Chair, William E. Clark
Charles B. Birdsong
Thomas W. Carpenter
Andrew I. Davol
Raymond G. Gordon
Brian S. Higgins
Ngozi Kamalu
Stephen M. Klisch
James G. LoCascio
Jesse Maddren
Fredrick B. Malmborg
James M. Meagher
A. Masoud Mehdizadeh
Joseph D. Mello

Ronald S. Mullisen
William R. Murray
Saeed B. Niku
Franklin C. Owen
Christopher C. Pascual
James Scott Patton
John R. Ridgely
Peter J. Schuster
Ramesh T. Shah
Kim A. Shollenberger
Glen E. Thorncroft
Yuen Cjen Yong

• Develop intellectually through continued learning.
• Make positive contributions to society.

Program Description

The profession of mechanical engineering is directed toward the design, manufacture, and system integration of a very wide variety of equipment ranging from manufacturing machinery and power generation equipment to consumer goods. Of central concern to mechanical engineers is the sound application of basic principles of solid mechanics, fluid mechanics and thermal sciences in the design, manufacture, and application of this equipment. Mechanical Engineering graduates obtain employment primarily with manufacturers, energy companies, consultants, and government agencies. Types of work performed by graduates include product design, mechanical design, testing, engineering management, engineering sales, design of manufacturing systems, and development of maintenance procedures. Mechanical Engineering graduates also often enhance their careers through graduate study in engineering, and some students also study engineering to build a scientific and technical foundation as a prelude to enrollment in medical, law, and business schools.

The focus of the Cal Poly Mechanical Engineering program is on education based on our “learn by doing” educational philosophy. Thus, the curriculum includes a large number of hands-on laboratories, integration of design throughout, and a senior project requirement for all students. Students are enrolled in engineering laboratories in all years of the curriculum. The program is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology.

The Mechanical Engineering Department is the home of the Donald E. Bently Center for Engineering Innovation. The center provides support for faculty, students, and visiting scholars for the advancement of research, education, and practice in mechanical engineering. In support of the center, Mr. Bently has established a $6 million endowment to fund three professorships.

Upper division students in the General Concentration can choose professional elective courses from such courses as turbomachinery, robotics, mechatronics, composite materials, rotor dynamics, advanced mechanics, solar systems, internal combustion engines, heat and mass transfer, and courses emphasizing the petroleum, air
conditioning, ventilating, and refrigeration industries. Students in the Mechatronics Concentration are prepared to enter the microprocessor based product design and factory automation job markets and to do advanced research in the areas of robotics, "intelligent" products and automated manufacturing.

There are six organized student clubs associated with the Mechanical Engineering Department. These are student chapters of the American Society of Mechanical Engineers, Society of Petroleum Engineers, Society of Automotive Engineers, American Society of Heating, Refrigerating and Air Conditioning Engineers, Alternative Energy Club, and the Pi Tau Sigma honorary society. All of these clubs offer students active programs in professional and leadership activities.

**Blended BS + MS Mechanical Engineering**

The blended program provides motivated students with an accelerated route to the MS Mechanical Engineering, with simultaneous conferring of both bachelor's and master's degrees. Students in the blended program are provided with a seamless process whereby they can progress from undergraduate to graduate status.

**Eligibility**

Students majoring in BS Mechanical Engineering may be eligible to pursue the blended program toward the MS Mechanical Engineering. Participation in the program is based on prior academic performance and other measures of professional promise, with a minimum GPA of 2.5 required (3.0 GPA recommended). Students are recommended for admission by a faculty committee. Please see page 96 for eligibility criteria.

**Program of Study**

The program allows students to complete a more meaningful capstone experience that integrates the senior project with the graduate thesis. This arrangement also increases opportunities for industrial interaction. Five of the nine units of ME 599 Thesis serve to complete the senior project requirement as long as the five units have associated with them the elements of design, build and test.

**Thesis Requirement**

Students must be prepared for engineering practice via the curriculum which culminates in a major design experience based on the knowledge and skills acquired in earlier coursework and incorporating engineering standards and realistic constraints, as listed in the ABET Engineering Criteria. Therefore, all “Blended BS + MS Program” students, even those students completing the Master of Science in Engineering, must have a master’s thesis with this major design experience requirement included in order to complete the undergraduate degree.
**Senior**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 422 Mechanical Control Systems</td>
<td>4</td>
</tr>
<tr>
<td>ME 440 Thermal System Design</td>
<td>4</td>
</tr>
<tr>
<td>ME 461, 462 Senior Project</td>
<td>4</td>
</tr>
<tr>
<td>Life science elective</td>
<td>1</td>
</tr>
<tr>
<td>Literature, philosophy, arts (300-400 level)</td>
<td>4</td>
</tr>
<tr>
<td>Advisor approved electives/Mechatronics</td>
<td>20</td>
</tr>
</tbody>
</table>

**MAJOR COURSES**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 151 Engineering Design Communication I</td>
<td>2</td>
</tr>
<tr>
<td>ME 152 Engineering Design Communication II</td>
<td>2</td>
</tr>
<tr>
<td>ME 134 Mechanical Systems (Transfer students must take ME 234)</td>
<td>3</td>
</tr>
<tr>
<td>ME 211 Engineering Statics</td>
<td>3</td>
</tr>
<tr>
<td>ME 212 Engineering Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>ME 236 Thermal Systems</td>
<td>3</td>
</tr>
<tr>
<td>ME 302 Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>ME 313 Heat Transfer</td>
<td>3</td>
</tr>
<tr>
<td>ME 318 Mechanical Vibrations</td>
<td>4</td>
</tr>
<tr>
<td>ME 326 Intermediate Dynamics</td>
<td>4</td>
</tr>
<tr>
<td>ME 328 Introduction to Design</td>
<td>4</td>
</tr>
<tr>
<td>ME 329 Intermediate Design</td>
<td>4</td>
</tr>
<tr>
<td>ME 341 Fluid Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>ME 342 Fluid Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>ME 344 Thermal Engineering</td>
<td>4</td>
</tr>
<tr>
<td>ME 345 Fluid Mechanics Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>ME 346 Thermal Science Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>ME 422 Mechanical Control Systems</td>
<td>4</td>
</tr>
<tr>
<td>ME 440 Thermal System Design</td>
<td>4</td>
</tr>
<tr>
<td>ME 461, 462 Senior Project</td>
<td>4</td>
</tr>
<tr>
<td>Life science elective (excluding ANT 250, BIO 113, BIO 114, and BIO 227) (B2)*</td>
<td>2.3</td>
</tr>
<tr>
<td>Literature, philosophy, arts (300-400 level) (C4)*</td>
<td>4</td>
</tr>
<tr>
<td>Advisor approved electives/Mechatronics</td>
<td>20</td>
</tr>
</tbody>
</table>

**SUPPORT COURSES**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 124 Gen Chem for Engineering (B3/B4)*</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 125 Gen Chem for Engineering</td>
<td>4</td>
</tr>
<tr>
<td>CSC 231 Fortran for Engineering Students or CSC 234 C and Unix</td>
<td>2/3</td>
</tr>
<tr>
<td>EE 201, 251 Electric Circuit Theory and Lab</td>
<td>3.1</td>
</tr>
<tr>
<td>EE 321, 361 Electronics and Lab</td>
<td>3.1</td>
</tr>
</tbody>
</table>

**GENERAL EDUCATION (GE)**

- 72 units required; 32 units are in Support.
- Minimum of 8 units required at the 300-400 level.

<table>
<thead>
<tr>
<th>Area</th>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area A</td>
<td>Communication (8 units)</td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>Expository Writing</td>
<td>4</td>
</tr>
<tr>
<td>A2</td>
<td>Oral Communication</td>
<td>4</td>
</tr>
<tr>
<td>A3</td>
<td>Reasoning, Argumentation, and Writing</td>
<td>4</td>
</tr>
</tbody>
</table>

**Area B Science and Mathematics**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>Mathematics/Statistics</td>
</tr>
<tr>
<td>B2</td>
<td>Life Science</td>
</tr>
<tr>
<td>B3</td>
<td>Physical Science</td>
</tr>
<tr>
<td>B4</td>
<td>One lab taken with either a B2 or B3 course</td>
</tr>
<tr>
<td>B5</td>
<td>(requirement for Liberal Arts students only)</td>
</tr>
<tr>
<td>B6</td>
<td>Upper-division Area B</td>
</tr>
<tr>
<td>B7</td>
<td>Additional Area B units</td>
</tr>
</tbody>
</table>

**Area C Arts and Humanities (16 units)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Literature</td>
</tr>
<tr>
<td>C2</td>
<td>Philosophy</td>
</tr>
<tr>
<td>C3</td>
<td>Fine/Performing Arts</td>
</tr>
<tr>
<td>C4</td>
<td>Upper-division elective</td>
</tr>
</tbody>
</table>

**Area D/E Society and the Individual (16 units)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>The American Experience</td>
</tr>
<tr>
<td>D2</td>
<td>Political Economy</td>
</tr>
<tr>
<td>D3</td>
<td>Comparative Social Institutions</td>
</tr>
</tbody>
</table>

**ELECTIVES**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGL 149 Technical Writing for Engineers (A3)*</td>
<td>4</td>
</tr>
<tr>
<td>IME 142 Mfg Processes: Materials Joining</td>
<td>2</td>
</tr>
<tr>
<td>IME 143 Mfg Processes: Material Removal</td>
<td>2</td>
</tr>
<tr>
<td>MATE 210, 215 Materials Engineering and Lab</td>
<td>3.1</td>
</tr>
<tr>
<td>MATH 141, 142 Calculus I, II (B1)*</td>
<td>4.4</td>
</tr>
<tr>
<td>MATH 143 Calculus III (Add’l Area B)*</td>
<td>4</td>
</tr>
<tr>
<td>MATH 241 Calculus IV</td>
<td>4</td>
</tr>
<tr>
<td>MATH 244 Linear Analysis I</td>
<td>4</td>
</tr>
<tr>
<td>MATH 344 Linear Analysis II (B6)*</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 131 General Physics (Add’l Area B)*</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 132, 133 General Physics</td>
<td>4.4</td>
</tr>
<tr>
<td>Manufacturing Processes elective</td>
<td>1</td>
</tr>
</tbody>
</table>

**Minimum of 8 units required at the 300-400 level.**

---

* = Satisfies General Education requirement

---

**2003-2005 Cal Poly Catalog**
CONCENTRATIONS (select one)

General Concentration
- ME 428 Design .............................................. 4
- EE 255 Energy Conversion Electromagnetics ........ 3
- EE 295 Energy Conversion Electromag Lab .......... 1
- Technical electives selected from emphasis area .... 12
  __________
  20

Mechatronics Concentration
- IME 157 Electronics Manufacturing .................. 4
- ME 405 Mechatronics ..................................... 4
- ME 406 Mechatronics Design ............................ 4
- ME 423 Robotics: Fundamentals and Applications 4
  ^ CPE 336 or IME 356 .................................... 4
  __________
  20

MS MECHANICAL ENGINEERING

General Characteristics
The Master of Science in Mechanical Engineering prepares students to design and develop advanced products and systems; to conduct research and analysis; to work in industry; or to continue study toward a Ph.D. Graduate students enjoy the same flavor of learn-by-doing as other Cal Poly students. Students may choose their technical electives in the area that interest them, including thermosciences, controls and robotics, mechanics and stress analysis, composite materials.

Prerequisites
For admission as a classified graduate student, in addition to the University requirements, an applicant should hold a BS degree in Mechanical Engineering with a grade point average of 3.0. Other closely related majors may be accepted as conditionally classified graduate students until they take necessary prerequisite mechanical engineering courses as approved by the graduate advisor. For additional information on University requirements, please refer to the Graduate Studies of this catalog.

MS MECHANICAL ENGINEERING

Core Courses
- ME 599 Design Project (Thesis) (2)(2)(5) or
  9 units of approved technical electives and a
  comprehensive examination ............................ 9
- Approved MATH/STAT/CSC courses .................. 8

Select a minimum of 12 units from the following: 12
- ME 502 Finite Element Analysis (4)
- ME 503 Inelastic Stress Analysis (4)
- ME 517 Advanced Vibrations (4)
- ME 531 Acoustics and Noise Control (3)
- ME 541 Advanced Thermodynamics (4)
- ME 542 Dynamics of Compressible Flow (4)
- ME 552 Conductive Heat Transfer (3)
- ME 553 Convective Heat Transfer (3)
- ME 554 Computational Heat Transfer (3)
- ME 575 Space Vehicle Dynamics (3)

Approved technical electives .......................... 16
(400 or 500-level ME or non-ME courses;
maximum of 12 units of 400-level courses allowed)

_________

1 Elective based on interests of students.